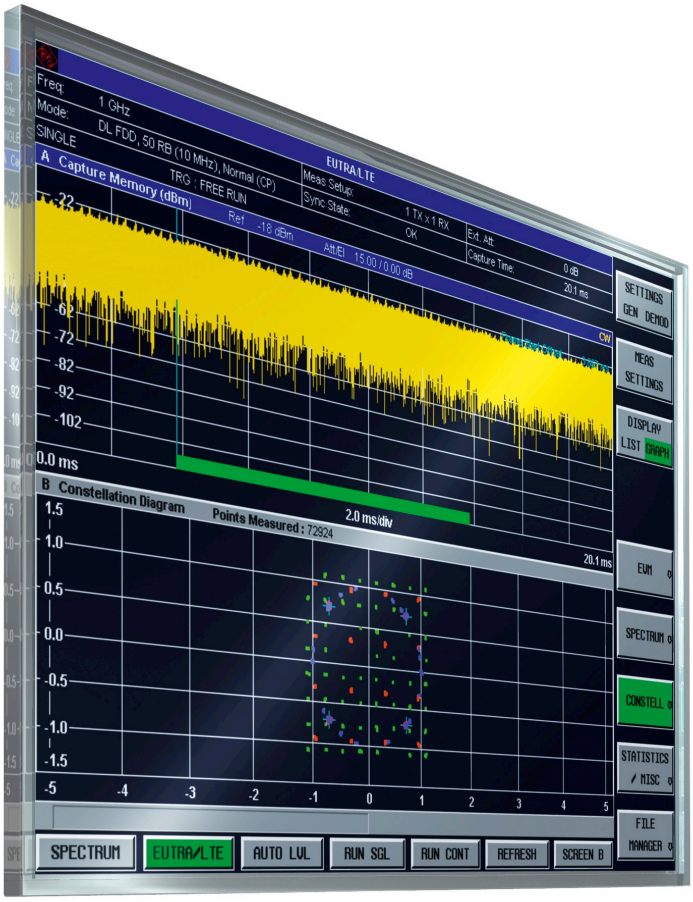
# R&S®FSQ-K10x (LTE Uplink)
# LTE Uplink Measurement Application
# User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following firmware applications:

- R&S®FSQ-K101 EUTRA / LTE FDD Uplink Measurement Application (1308.9006.02)
- R&S®FSQ-K105 EUTRA / LTE TDD Uplink Measurement Application (1309.9000.02)

This manual is applicable for the following R&S analyzer models with firmware 4.7x SP4 and higher:

- R&S®FSQ3 (1307.9002K03)
- R&S®FSQ8 (1307.9002K07)
- R&S®FSQ26 (1307.9002K13)
- R&S®FSQ40 (1307.9002K30)
- R&S®FSG8 (1309.0002.08)
- R&S®FSG13 (1309.0002.13)

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Muehldorfstr. 15, 81671 Munich, Germany
Phone: +49 89 41 29 - 0
Fax: +49 89 41 29 12 164
E-mail: info@rohde-schwarz.com
Internet: http://www.rohde-schwarz.com
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The following abbreviations are used throughout this manual: R&S®FSQ is abbreviated as R&S FSQ.

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**Asia/Pacific**

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customersupport.asia@rohde-schwarz.com

**China**

Phone +86-800-810-8228 /
+86-400-650-5896
customersupport.china@rohde-schwarz.com


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# 1 Preface

## 1.1 Documentation Overview

The user documentation for the R&S FSQ consists of the following parts:

- "Getting Started" printed manual
- Documentation CD-ROM with:
  - Getting Started
  - User Manuals for base unit and options
  - Service Manual
  - Release Notes
  - Data sheet and product brochures

**Getting Started**

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and handling are described. Safety information is also included.

**User Manuals**

User manuals are provided for the base unit and each additional (software) option.

The user manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the user manuals, all instrument functions are described in detail. Furthermore, they provide a complete description of the remote control commands with programming examples.

The user manual for the base unit provides basic information on operating the R&S FSQ in general, and the Spectrum mode in particular. Furthermore, the software options that enhance the basic functionality for various measurement modes are described here. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the individual option manuals, the specific instrument functions of the option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S FSQ is not included in the option manuals.

**Service Manual**

This manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FSQ by replacing modules.

**Release Notes**

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes. The most recent release notes are provided in the Internet.

## 1.2 Typographical Conventions

The following text markers are used throughout this documentation:

| Convention | Description |
|---|---|
| "Graphical user interface elements" | All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks. |
| KEYS | Key names are written in capital letters. |
| `File names, commands, program code` | File names, commands, coding samples and screen output are distinguished by their font. |
| *Input* | Input to be entered by the user is displayed in italics. |
| Links | Links that you can click are displayed in blue font. |
| "References" | References to other parts of the documentation are enclosed by quotation marks. |

# 2 Introduction

Currently, UMTS networks worldwide are being upgraded to high speed downlink packet access (HSDPA) in order to increase data rate and capacity for downlink packet data. In the next step, high speed uplink packet access (HSUPA) will boost uplink performance in UMTS networks. While HSDPA was introduced as a 3GPP Release 5 feature, HSUPA is an important feature of 3GPP Release 6. The combination of HSDPA and HSUPA is often referred to as HSPA.

However, even with the introduction of HSPA, the evolution of UMTS has not reached its end. HSPA+ will bring significant enhancements in 3GPP Release 7. The objective is to enhance the performance of HSPA-based radio networks in terms of spectrum efficiency, peak data rate and latency, and to exploit the full potential of WCDMAbased 5 MHz operation. Important features of HSPA+ are downlink multiple input multiple output (MIMO), higher order modulation for uplink and downlink, improvements of layer 2 protocols, and continuous packet connectivity.

In order to ensure the competitiveness of UMTS for the next 10 years and beyond, concepts for UMTS long term evolution (LTE) have been investigated. The objective is a high-data-rate, low-latency and packet-optimized radio access technology. Therefore, a study item was launched in 3GPP Release 7 on evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). LTE/EUTRA will then form part of 3GPP Release 8 core specifications.

This introduction focuses on LTE/EUTRA technology. In the following, the terms LTE or EUTRA are used interchangeably.

In the context of the LTE study item, 3GPP work first focused on the definition of requirements, e.g. targets for data rate, capacity, spectrum efficiency, and latency. Also commercial aspects such as costs for installing and operating the network were considered. Based on these requirements, technical concepts for the air interface transmission schemes and protocols were studied. Notably, LTE uses new multiple access schemes on the air interface: orthogonal frequency division multiple access (OFDMA) in downlink and single carrier frequency division multiple access (SC-FDMA) in uplink. Furthermore, MIMO antenna schemes form an essential part of LTE. In an attempt to simplify protocol architecture, LTE brings some major changes to the existing UMTS protocol concepts. Impact on the overall network architecture including the core network is being investigated in the context of 3GPP system architecture evolution (SAE).

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## 2.1 Requirements for UMTS Long-Term Evolution

LTE is focusing on optimum support of packet switched (PS) services. Main requirements for the design of an LTE system are documented in 3GPP TR 25.913 [1] and can be summarized as follows:

- Data Rate: Peak data rates target 100 Mbps (downlink) and 50 Mbps (uplink) for 20 MHz spectrum allocation, assuming two receive antennas and one transmit antenna are at the terminal.
- Throughput: The target for downlink average user throughput per MHz is three to four times better than Release 6. The target for uplink average user throughput per MHz is two to three times better than Release 6.
- Spectrum efficiency: The downlink target is three to four times better than Release 6. The uplink target is two to three times better than Release 6.
- Latency: The one-way transit time between a packet being available at the IP layer in either the UE or radio access network and the availability of this packet at IP layer in the radio access network/UE shall be less than 5 ms. Also C-plane latency shall be reduced, e.g. to allow fast transition times of less than 100 ms from camped state to active state.
- Bandwidth: Scaleable bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz shall be supported. Also bandwidths smaller than 5 MHz shall be supported for more flexibility.
- Interworking: Interworking with existing UTRAN/GERAN systems and non-3GPP systems shall be ensured. Multimode terminals shall support handover to and from UTRAN and GERAN as well as inter-RAT measurements. Interruption time for handover between EUTRAN and UTRAN/GERAN shall be less than 300 ms for realtime services and less than 500 ms for non-realtime services.
- Multimedia broadcast multicast services (MBMS): MBMS shall be further enhanced and is then referred to as E-MBMS.
- Costs: Reduced CAPEX and OPEX including backhaul shall be achieved. Costeffective migration from Release 6 UTRA radio interface and architecture shall be possible. Reasonable system and terminal complexity, cost, and power consumption shall be ensured. All the interfaces specified shall be open for multivendor equipment interoperability.
- Mobility: The system should be optimized for low mobile speed (0 to 15 km/h), but higher mobile speeds shall be supported as well, including high speed train environment as a special case.
- Spectrum allocation: Operation in paired (frequency division duplex / FDD mode) and unpaired spectrum (time division duplex / TDD mode) is possible.
- Co-existence: Co-existence in the same geographical area and co-location with GERAN/UTRAN shall be ensured. Also, co-existence between operators in adjacent bands as well as cross-border co-existence is a requirement.
- Quality of Service: End-to-end quality of service (QoS) shall be supported. VoIP should be supported with at least as good radio and backhaul efficiency and latency as voice traffic over the UMTS circuit switched networks.
- Network synchronization: Time synchronization of different network sites shall not be mandated.

# 2.2 Long-Term Evolution Uplink Transmission Scheme

## 2.2.1 SC-FDMA

During the study item phase of LTE, alternatives for the optimum uplink transmission scheme were investigated. While OFDMA is seen optimum to fulfil the LTE requirements in downlink, OFDMA properties are less favourable for the uplink. This is mainly due to weaker peak-to-average power ratio (PAPR) properties of an OFDMA signal, resulting in worse uplink coverage.

Thus, the LTE uplink transmission scheme for FDD and TDD mode is based on SCFDMA with a cyclic prefix. SC-FDMA signals have better PAPR properties compared to an OFDMA signal. This was one of the main reasons for selecting SC-FDMA as LTE uplink access scheme. The PAPR characteristics are important for cost-effective design of UE power amplifiers. Still, SC-FDMA signal processing has some similarities with OFDMA signal processing, so parameterization of downlink and uplink can be harmonized.

There are different possibilities how to generate an SC-FDMA signal. DFT-spread- OFDM (DFT-s-OFDM) has been selected for EUTRA. The principle is illustrated in figure 2-1.

For DFT-s-OFDM, a size-M DFT is first applied to a block of M modulation symbols. QPSK, 16QAM and 64 QAM are used as uplink EUTRA modulation schemes, the latter being optional for the UE. The DFT transforms the modulation symbols into the frequency domain. The result is mapped onto the available sub-carriers. In EUTRA uplink, only localized transmission on consecutive sub-carriers is allowed. An N point IFFT where N>M is then performed as in OFDM, followed by addition of the cyclic prefix and parallel to serial conversion.

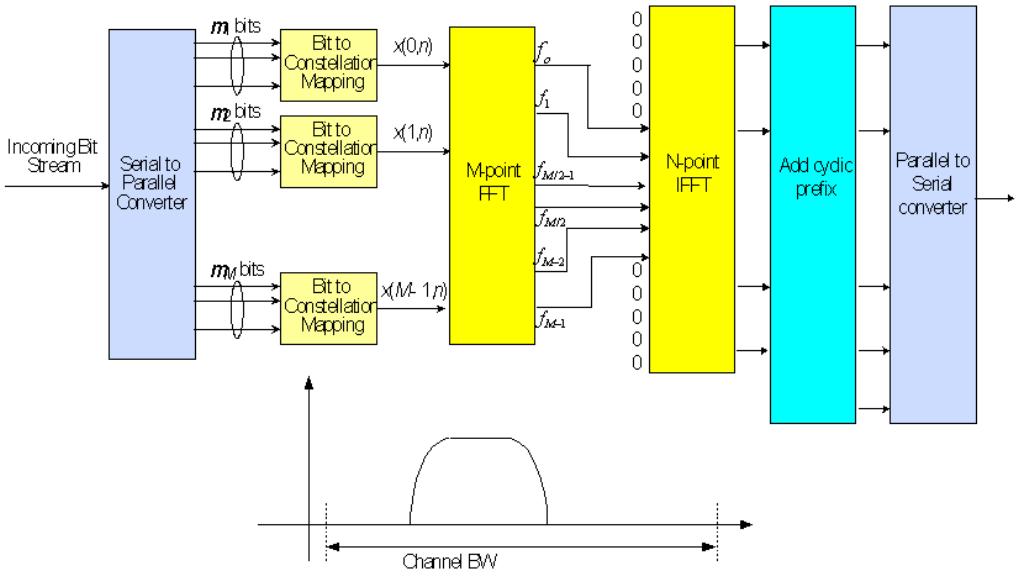


*Fig. 2-1: Block Diagram of DFT-s-OFDM (Localized Transmission)*

The DFT processing is therefore the fundamental difference between SC-FDMA and OFDMA signal generation. This is indicated by the term DFT-spread-OFDM. In an SCFDMA signal, each sub-carrier used for transmission contains information of all transmitted modulation symbols, since the input data stream has been spread by the DFT transform over the available sub-carriers. In contrast to this, each sub-carrier of an OFDMA signal only carries information related to specific modulation symbols.

### 2.2.2 SC-FDMA Parameterization

The EUTRA uplink structure is similar to the downlink. An uplink radio frame consists of 20 slots of 0.5 ms each, and 1 subframe consists of 2 slots. The slot structure is shown in figure 2-2.

Each slot carries $N^{UL}_{symb}$ SC-FDMA symbols, where $N^{UL}_{symb}$ = 7 for the normal cyclic prefix and $N^{UL}_{symb}$ = 6 for the extended cyclic prefix. SC-FDMA symbol number 3 (i.e. the 4th symbol in a slot) carries the reference signal for channel demodulation.

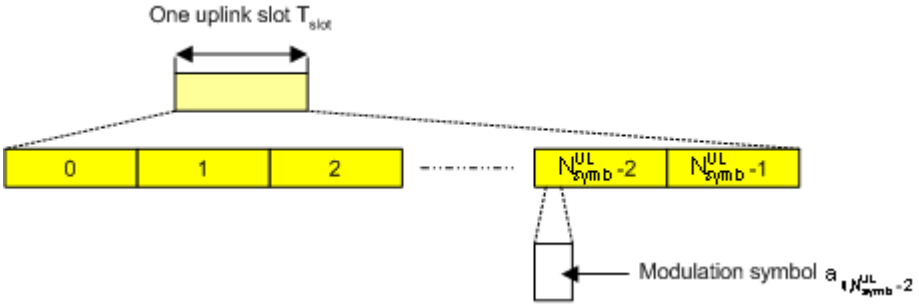


*Fig. 2-2: Uplink Slot Structure*

Also for the uplink, a bandwidth agnostic layer 1 specification has been selected. The table below shows the configuration parameters in an overview table.

| Configuration | Number of symbols $N^{UL}_{symb}$ | Cyclic prefix length in samples | Cyclic prefix length in µs |
|---|---|---|---|
| Normal cyclic prefix Δf=15kHz | 7 | 160 for first symbol<br>144 for other symbols | 5.2 µs for first symbol<br>4.7 µs for other symbols |
| Extended cyclic prefix Δf=15kHz | 6 | 512 | 16.7 µs |

### 2.2.3 Uplink Data Transmission

In uplink, data is allocated in multiples of one resource block. Uplink resource block size in the frequency domain is 12 sub-carriers, i.e. the same as in downlink. However, not all integer multiples are allowed in order to simplify the DFT design in uplink signal processing. Only factors 2, 3, and 5 are allowed.

The uplink transmission time interval (TTI) is 1 ms (same as downlink).

User data is carried on the Physical Uplink Shared Channel (**PUSCH**) that is determined by the transmission bandwidth NTx and the frequency hopping pattern k0.

The Physical Uplink Control Channel (**PUCCH**) carries uplink control information, e.g. CQI reports and ACK/NACK information related to data packets received in the downlink. The PUCCH is transmitted on a reserved frequency region in the uplink.

### 2.2.4 Uplink Reference Signal Structure

Uplink reference signals are used for two different purposes: on the one hand, they are used for channel estimation in the eNodeB receiver in order to demodulate control and data channels. On the other hand, the reference signals provide channel quality information as a basis for scheduling decisions in the base station. The latter purpose is also called channel sounding.

The uplink reference signals are based on CAZAC (Constant Amplitude Zero Auto- Correlation) sequences.

### 2.2.5 Uplink Physical Layer Procedures

For EUTRA, the following uplink physical layer procedures are especially important:

**Non-synchronized random access**

Random access may be used to request initial access, as part of handover, when transiting from idle to connected, or to re-establish uplink synchronization. The structure is shown in figure 2-3.

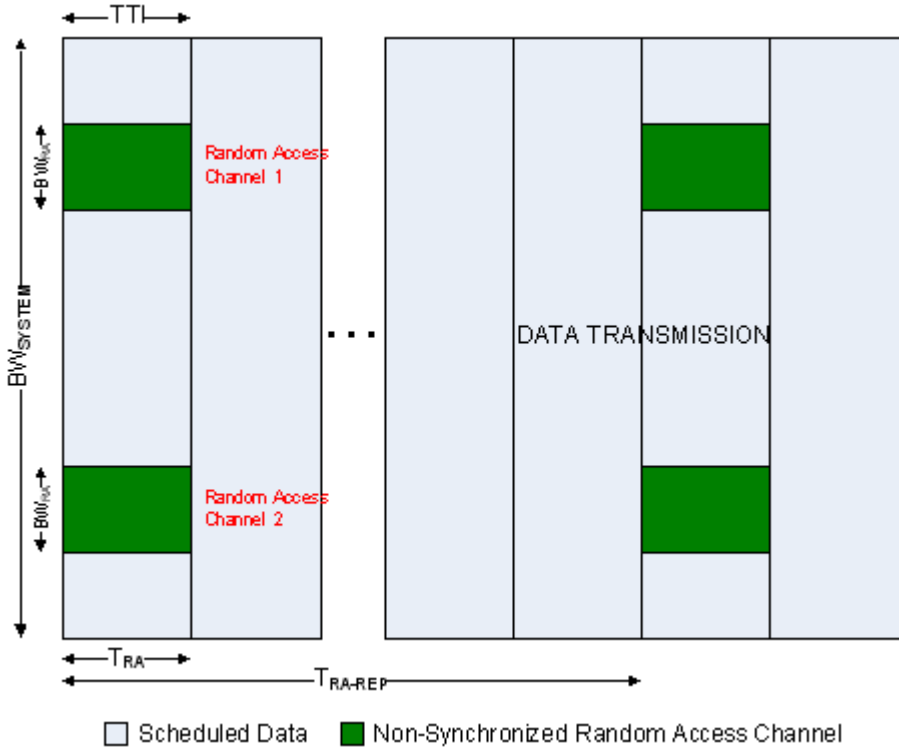


*Fig. 2-3: Random Access Structure, principle*

Multiple random access channels may be defined in the frequency domain within one access period $T_{RA}$ in order to provide a sufficient number of random access opportunities.

For random access, a preamble is defined as shown in figure 2-4. The preamble sequence occupies $T_{PRE}$ = 0.8 ms and the cyclic prefix occupies $T_{CP}$ = 0.1 ms within one subframe of 1 ms. During the guard time $T_{GT}$, nothing is transmitted. The preamble bandwidth is 1.08 MHz (72 sub-carriers). Higher layer signalling controls in which subframes the preamble transmission is allowed, and the location in the frequency domain. Per cell, there are 64 random access preambles. They are generated from Zadoff-Chu sequences.

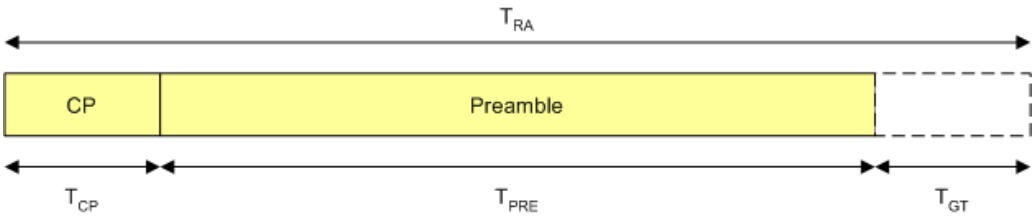


***Fig. 2-4: Random Access Preamble***

The random access procedure uses open loop power control with power ramping similar to WCDMA. After sending the preamble on a selected random access channel, the UE waits for the random access response message. If no response is detected then another random access channel is selected and a preamble is sent again.

### Uplink scheduling

Scheduling of uplink resources is done by eNodeB. The eNodeB assigns certain time/frequency resources to the UEs and informs UEs about transmission formats to use. Scheduling decisions affecting the uplink are communicated to the UEs via the Physical Downlink Control Channel (PDCCH) in the downlink. The scheduling decisions may be based on QoS parameters, UE buffer status, uplink channel quality measurements, UE capabilities, UE measurement gaps, etc.

### Uplink link adaptation

As uplink link adaptation methods, transmission power control, adaptive modulation and channel coding rate, as well as adaptive transmission bandwidth can be used.

### Uplink timing control

Uplink timing control is needed to time align the transmissions from different UEs with the receiver window of the eNodeB. The eNodeB sends the appropriate timing-control commands to the UEs in the downlink, commanding them to adapt their respective transmit timing.

### Hybrid automatic repeat request (ARQ)

The Uplink Hybrid ARQ protocol is already known from HSUPA. The eNodeB has the capability to request retransmissions of incorrectly received data packets.

## 2.3 References

[1] 3GPP TS 25.913: Requirements for E-UTRA and E-UTRAN (Release 7)

[2] 3GPP TR 25.892: Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)

[3] 3GPP TS 36.211 v8.3.0: Physical Channels and Modulation (Release 8)

[4] 3GPP TS 36.300: E-UTRA and E-UTRAN; Overall Description; Stage 2 (Release 8)

[5] 3GPP TS 22.978: All-IP Network (AIPN) feasibility study (Release 7)

[6] 3GPP TS 25.213: Spreading and modulation (FDD)

[7] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM – Part I. IEEE Trans. on Commun. Vol. 47 (1999) No. 11, pp. 1668-1677.

[8] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for OFDM-Based Broadband Transmission – Part II: A Case Study. IEEE Trans. on Commun. Vol. 49 (2001) No. 4, pp. 571-578.

# 3 Welcome

The EUTRA/LTE software application makes use of the I/Q capture functionality of the following spectrum and signal analyzers to enable EUTRA/LTE TX measurements conforming to the EUTRA specification.

- R&S FSQ
- R&S FSG

This manual contains all information necessary to configure, perform and analyze such measurements.

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- Application Overview....16
- Support....18

## 3.1 Installing the Software

For information on the installation procedure see the release notes of the R&S FSQ.

## 3.2 Application Overview

### Starting the application

Access the application via the "Mode" menu.

► Press the MODE key and select "LTE".
Note that you may have to browse through the "Mode" menu with the "Next" key to find the LTE entry.

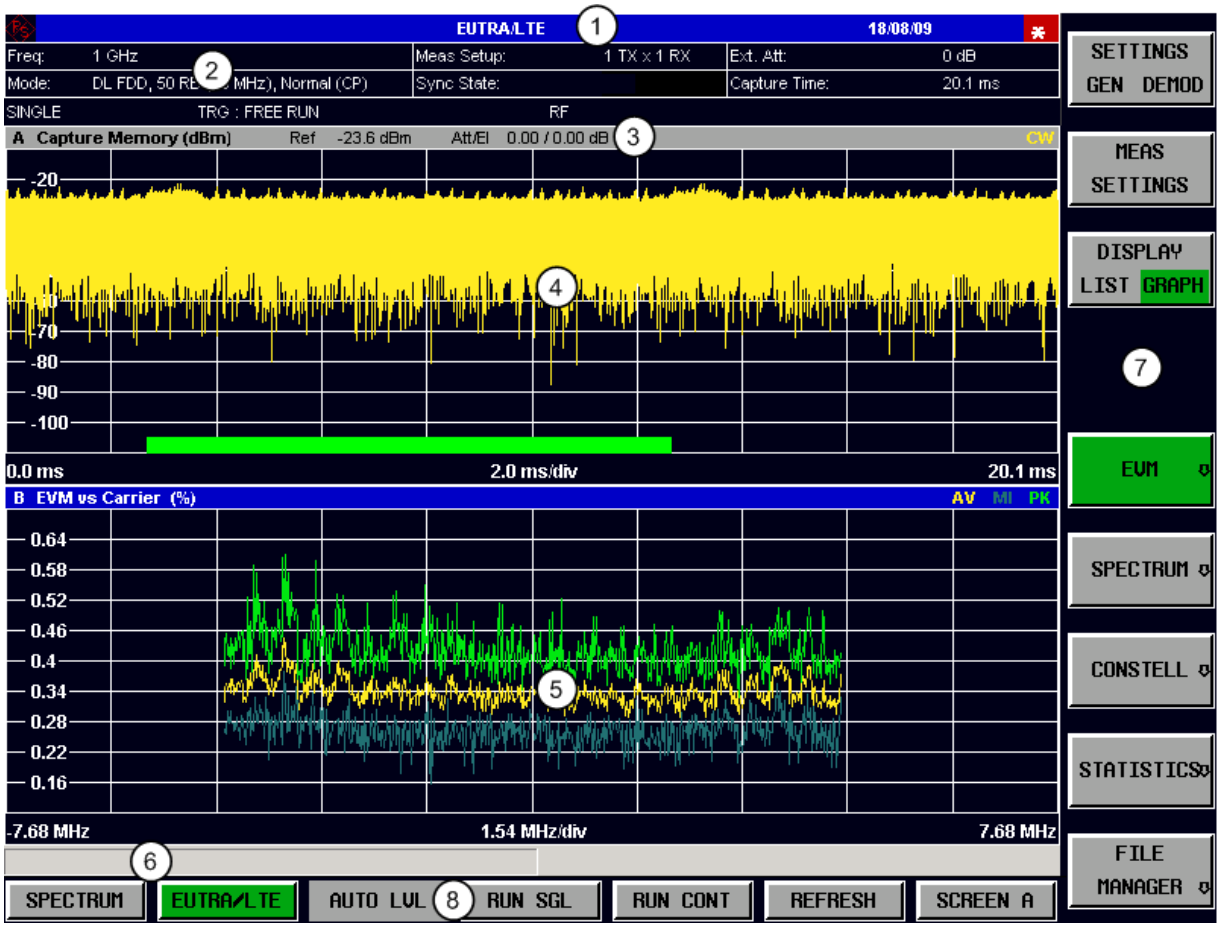
### Presetting the software

When you first start the software, all settings are in their default state. After you have changed any parameter, you can restore the default state with the PRESET key.

`CONFigure:PRESet` on page 131

### Elements and layout of the user interface

The user interface of the LTE measurement application is made up of several elements.




1 = Title Bar: shows the currently active measurement application
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the display trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows the measurement results
6 = Status Bar: shows the measurement progress, software messages and errors
7 = Softkeys: open settings dialogs and select result displays
8 = Hotkeys: control the measurement process (e.g. running a measurement)

### The status and title bar

The title bar at the very top of the screen shows the name of the application currently running.

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

### Display of measurement settings

The header table above the result displays shows information on hardware and measurement settings.

The header table includes the following information

- **Freq**
  The analyzer RF frequency.
- **Mode**
  Link direction, duplexing, cyclic prefix and maximum number of physical resource blocks (PRBs) / signal bandwidth.
- **Meas Setup**
  Shows number of transmitting and receiving antennas.
- **Sync State**
  The following synchronization states may occur:
  – **OK** The synchronization was successful.
  – **FAIL** The synchronization has failed.

  SCPI Command:
  `[SENSe]:SYNC[:STATe]?` on page 83
- **Ext. Att**
  Shows the external attenuation in dB.
- **Capture Time**
  Shows the capture length in ms.

## 3.3 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

To make the solution easier, use the "R&S Support" softkey to export useful information for troubleshooting. The R&S FSQ stores the information in a number of files that are located in the R&S FSQ directory `C:\R_S\Instr\user\LTE\Support`. If you contact Rohde & Schwarz to get help on a certain problem, send these files to the support in order to identify and solve the problem faster.

# 4 Measurement Basics

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.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## 4.1 Symbols and Variables

The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

| | |
|---|---|
| $a_{l,k}\hat{a}_{l,k}$ | data symbol (actual, decided) |
| $A_{l,k}$ | data symbol after DFT-precoding |
| $\Delta f$, $\Delta \hat{f}_{coarse}$ | carrier frequency offset between transmitter and receiver (actual, coarse estimate) |
| $\Delta f_{res}$ | residual carrier frequency offset |
| $\zeta$ | relative sampling frequency offset |
| $H_{l,k}$, $\hat{H}_{l,k}$ | channel transfer function (actual, estimate) |
| i | time index |
| $\hat{i}_{coarse}$, $\hat{i}_{fine}$ | timing estimate (coarse, fine) |
| k | subcarrier index |
| l | SC-FDMA symbol index |
| $N_{DS}$ | number of SC-FDMA data symbols |
| $N_{FFT}$ | length of FFT |
| $N_g$ | number of samples in cyclic prefix (guard interval) |
| $N_s$ | number of Nyquist samples |
| $N_{TX}$ | number of allocated subcarriers |
| $N_{k,l}$ | noise sample |
| n | index of modulated QAM symbol before DFT precoding |
| $\Phi_l$ | common phase error |
| $r_i$ | received sample in the time domain |
| $R'_{k,l}$ | uncompensated received sample in the frequency domain |

| | |
|---|---|
| $r_{n,l}$ | equalized received symbols of measurement path after IDFT |
| T | duration of the useful part of an SC-FDMA symbol |
| $T_g$ | duration of the guard interval |
| $T_s$ | total duration of SC-FDMA symbol |

## 4.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.

The contents of this chapter are structered like the DSP.

## 4.3 The LTE Uplink Analysis Measurement Application

The block diagram in figure 4-1 shows the general structure of the LTE uplink measurement application from the capture buffer containing the I/Q data up to the actual analysis block.

After synchronization a fully compensated signal is produced in the reference path (purple) which is subsequently passed to the equalizer. An IDFT of the equalized symbols yields observations for the QAM transmit symbols $a_{n,l}$ from which the data estimates $\hat{a}_{n,l}$ are obtained via hard decision. Likewise a user defined compensation as well as equalization is carried out in the measurement path (cyan) and after an IDFT the observations of the QAM transmit symbols are provided. Accordingly, the measurement path might still contain impairments which are compensated in the reference path. The symbols of both signal processing paths form the basis for the analysis.

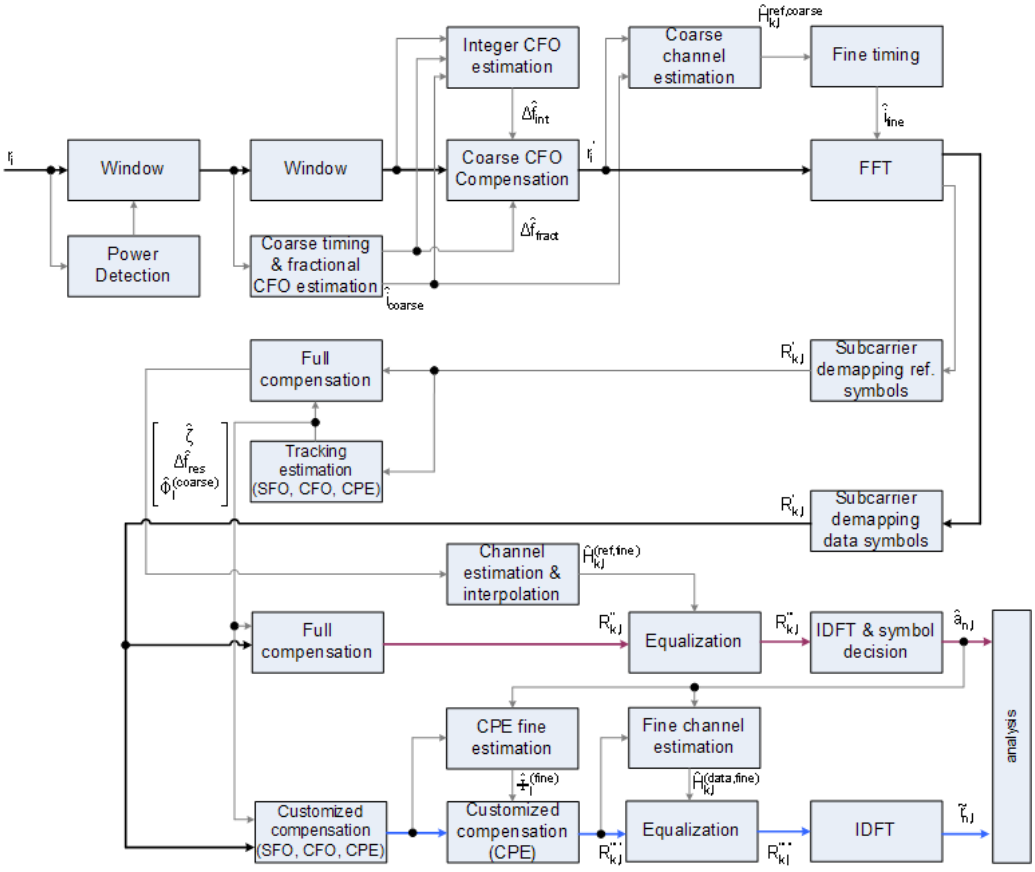



*Fig. 4-1: Block diagram for the LTE UL measurement application*

### 4.3.1 Synchronization

In a first step the areas of sufficient power are identified within the captured I/Q data stream which consists of the receive samples $r_i$. For each area of sufficient power, the analyzer synchronizes on subframes of the uplink generic frame structure [3]. After this coarse timing estimation, the fractional part as well as the integer part of the carrier frequency offset (CFO) are estimated and compensated. In order to obtain an OFDM demodulation via FFT of length $N_{FFT}$ that is not corrupted by ISI, a fine timing is established which refines the coarse timing estimate.

A phase tracking based on the reference SC-FDMA symbols is performed in the frequency domain. The corresponding tracking estimation block provides estimates for

- the relative sampling frequency offset ζ
- the residual carrier frequency offset $\Delta f_{res}$
- the common phase error $\Phi_l$

According to references [7] and [8], the uncompensated samples $R'_{k,l}$ in the DFT-precoded domain can be stated as

$$R'_{k,l} = A_{k,l} \cdot H_{k,l} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{k,l}$$

(4 - 1)

with

- the DFT precoded data symbol $A_{k,l}$ on subcarrier k at SC-FDMA symbol l,
- the channel transfer function $H_{k,l}$,
- the number of Nyquist samples $N_S$ within the total duration $T_S$,
- the duration of the useful part of the SC-FDMA symbol $T=T_S-T_g$
- the independent and Gaussian distributed noise sample $N_{k,l}$

Within one SC-FDMA symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $R'_{k,l}$ completely in the reference path and according to the user settings in the measurement path. Thus the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decoded the data symbols in the reference path, an additional data-aided phase tracking can be utilized to refine the common phase error estimation.

### 4.3.2 Analysis

The analysis block of the EUTRA/LTE uplink measurement application allows to compute a variety of measurement variables.

**EVM**

The most important variable is the error vector magnitude which is defined as

$$EVM_{l,k} = \frac{\left|\tilde{r}_{n,l} - \hat{a}_{n,l}\right|}{\sqrt{E\left\{\left|a_{n,l}\right|^2\right\}}}$$

(4 - 2)

for QAM symbol n before precoding and SC-FDMA symbol l. Since the normalized average power of all possible constellations is 1, the equation can be simplified to

$$EVM_{n,l} = \left|\tilde{r}_{n,l} - \hat{a}_{n,l}\right|$$

(4 - 3)

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{DS} N_{TX}} \sum_{l=0}^{N_{LB}-1} \sum_{n=0}^{N_{TX}-1} EVM_{n,l}^2}$$

(4 - 4)

for $N_{DS}$ SC-FDMA data symbols and the $N_{TX}$ allocated subcarriers.

**I/Q imbalance**

The I/Q imbalance contained in the continuous received signal r(t) can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(4 - 5)

where s(t) is the transmit signal and I and Q are the weighting factors describing the I/Q imbalance. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(4 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(4 - 7)

based on the complex-valued estimate $\widehat{\Delta Q}$.

**Basic in-band emissions measurement**

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

The relative in-band emissions are given by

$$Emissions_{relative}(\Delta_{RB}) = \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_S| \cdot N_{RB}} \sum_{t \in T_S} \sum_{c}^{c+12 \cdot N_{RB}-1} |Y(t,f)|^2}$$

(4 - 8)

where $T_S$ is a set $|T_S|$ of SC-FDMA symbols with the considered modulation scheme being active within the measurement period, $\Delta_{RB}$ is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. $\Delta_{RB}$=1 or $\Delta_{RB}$=-1 for the first adjacent RB), c is the lower edge of the allocated BW, and Y(t,f) is the frequency domain signal evaluated for in-band emissions. $N_{RB}$ is the number of allocated RBs .

The basic in-band emissions measurement interval is defined over one slot in the time domain.

**Other measurement variables**

Without going into detail, the EUTRA/LTE uplink measurement application additionally provides the following results:

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

# 5 Measurements and Result Displays

The LTE measurement application features several measurements to examine and analyze different aspects of an LTE signal.

The source of the data that is processed is either a live signal or a previously recorded signal whose characteristics have been saved to a file. For more information see "Selecting the Input Source" on page 50.


- Numerical Results....25
- Measuring the Power Over Time....27
- Measuring the Error Vector Magnitude (EVM)....28
- Measuring the Spectrum....30
- Measuring the Symbol Constellation....36
- Measuring Statistics....37


## 5.1 Numerical Results

Result Summary....25

**Result Summary**
The Result Summary shows all relevant measurement results in numerical form, combined in one table.

▸ Press the "Display (List Graph)" softkey so that the "List" element turns green to view the Result Summary.

SCPI command:

`DISPlay[:WINDow<n>]:TABLe` on page 80

**Contents of the result summary**

| Result Summary | | | | | | |
|---|---|---|---|---|---|---|
| Frame Results | Min | Mean | Limit | Max | Limit | Unit |
| EVM PUSCH QPSK | | 0.31 | 17.50 | | | % |
| EVM PUSCH 16QAM | | | 12.50 | | | % |
| EVM PUSCH 64QAM | | | | | | % |
| Results for Selection | Subframe(s) ALL | | Slot(s) ALL | | Symbols meas. | 140 |
| EVM All | 0.26 | 0.30 | | 0.33 | | % |
| EVM Phys. Channel | 0.27 | 0.30 | | 0.34 | | % |
| EVM Phys. Signal | 0.23 | 0.28 | | 0.33 | | % |
| Frequency Error | -40.89 | -39.51 | | -38.27 | | Hz |
| Sampling Error | -0.06 | -0.03 | | -0.01 | | ppm |
| IQ Offset | -79.56 | -77.57 | | -75.40 | | dB |
| IQ Gain Imbalance | -0.00 | 0.00 | | 0.00 | | dB |
| IQ Quadrature Error | 0.03 | 0.03 | | 0.04 | | ° |
| Power | -30.87 | -30.87 | | -30.87 | | dBm |
| Crest Factor | | 5.87 | | | | dB |

The table is split in two parts. The first part shows results that refer to the complete frame. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

In addition to the red font, the application also puts a red star ( ) in front of failed results.

- **EVM PUSCH QPSK**
  Shows the EVM for all QPSK-modulated resource elements of the PUSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:USQP[:AVERage]?` on page 88
- **EVM PUSCH 16QAM**
  Shows the EVM for all 16QAM-modulated resource elements of the PUSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:USST[:AVERage]?` on page 88
- **EVM DRMS PUSCH QPSK**
  Shows the EVM of all DMRS resource elements with QPSK modulation of the PUSCH in the analyzed frame.
  `FETCh:SUMMary:EVM:SDQP[:AVERage]?` on page 87
- **EVM DRMS PUSCH 16QAM**
  Shows the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH in the analyzed frame.
  `FETCh:SUMMary:EVM:SDST[:AVERage]?` on page 87

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the slots.

The header row of the table contains information about the selection you have made (like the subframe).

- **EVM All**
  Shows the EVM for all resource elements in the analyzed frame.
  `FETCh:SUMMary:EVM[:ALL][:AVERage]?` on page 86
- **EVM Phys Channel**
  Shows the EVM for all physical channel resource elements in the analyzed frame.
  `FETCh:SUMMary:EVM:PCHannel[:AVERage]?` on page 86
- **EVM Phys Signal**
  Shows the EVM for all physical signal resource elements in the analyzed frame.
  `FETCh:SUMMary:EVM:PSIGnal[:AVERage]?` on page 86
- **Frequency Error**
  Shows the difference in the measured center frequency and the reference center frequency.
  `FETCh:SUMMary:FERRor[:AVERage]?` on page 88
- **Sampling Error**
  Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
  `FETCh:SUMMary:SERRor[:AVERage]?` on page 90
- **I/Q Offset**
  Shows the power at spectral line 0 normalized to the total transmitted power.
  `FETCh:SUMMary:IQOFfset[:AVERage]?` on page 89

- **I/Q Gain Imbalance**
  Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
  FETCh:SUMMary:GIMBalance[:AVERage]? on page 89
- **I/Q Quadrature Error**
  Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
  FETCh:SUMMary:QUADerror[:AVERage]? on page 90
- **Power**
  Shows the average time domain power of the analyzed signal.
  FETCh:SUMMary:POWer[:AVERage]? on page 89
- **Crest Factor**
  Shows the peak-to-average power ratio of captured signal.
  FETCh:SUMMary:CRESt[:AVERage]? on page 85

## 5.2 Measuring the Power Over Time

This chapter contains information on all measurements that show the power of a signal over time.

Capture Buffer.....27

**Capture Buffer**
The capture buffer result display shows the complete range of captured data for the last data capture. The x-axis represents the time scale. The maximum value of the x-axis is equal to the capture length that you can set in the General Settings dialog box. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).

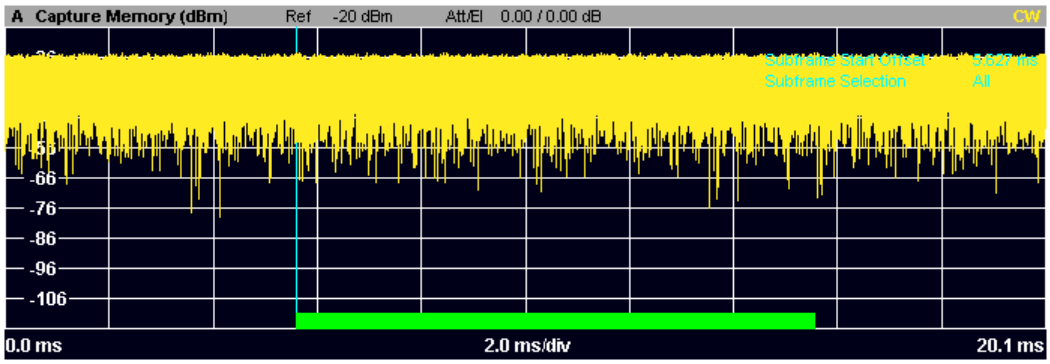



*Fig. 5-1: Capture buffer without zoom*

The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode.

The green bar at the bottom of the diagram represents the frame that is currently analyzed.

A blue vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the diagram includes the Subframe Start Offset value (blue text). This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.

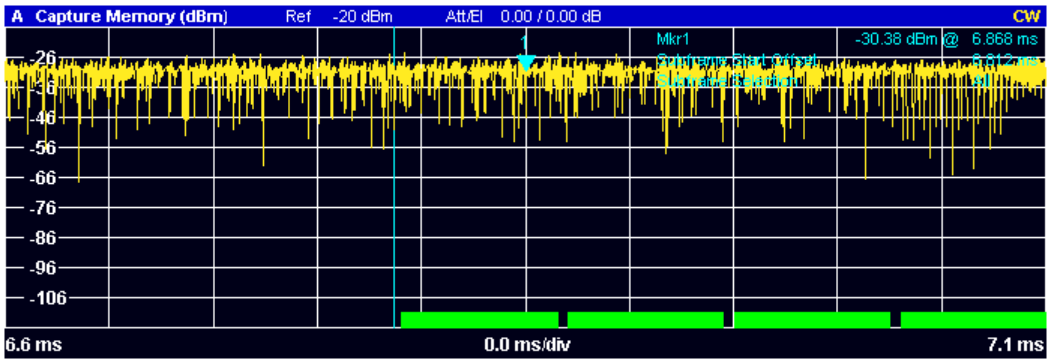



***Fig. 5-2: Capture buffer after a zoom has been applied***

SCPI command:
CALCulate<n>:FEED 'PVT:CBUF'
TRACe:DATA?

## 5.3 Measuring the Error Vector Magnitude (EVM)

This chapter contains information on all measurements that show the error vector magnitude (EVM) of a signal.

The EVM is one of the most important indicators for the quality of a signal. For more information on EVM calculation methods refer to chapter 4, "Measurement Basics", on page 19.

EVM vs Carrier....28
EVM vs Symbol....29
EVM vs Subframe....30

**EVM vs Carrier**
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

The results are based on an average EVM that is calculated over the OFDM symbols used by the subcarriers. This average subcarrier EVM is determined for each analyzed slot in the capture buffer.

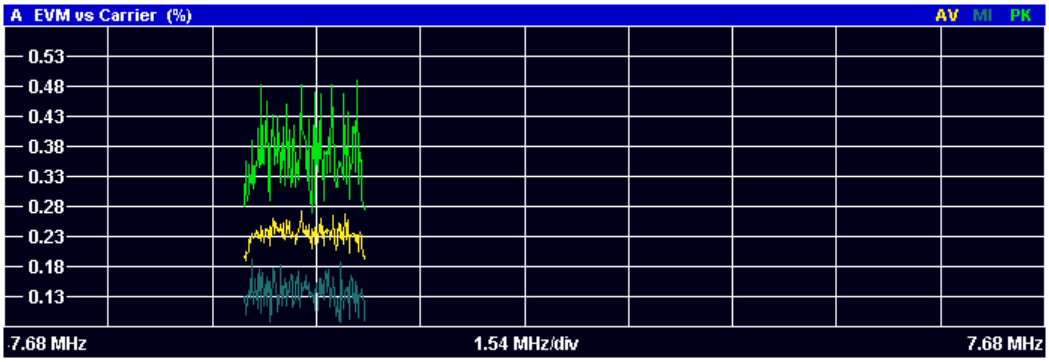
If you analyze all slots, the result display contains three traces.

- Average EVM
  This trace shows the subcarrier EVM averaged over all slots.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed slots.
- Maximum EVM

This trace shows the highest (average) subcarrier EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the subcarrier EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 68

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.




SCPI command:
CALCulate<n>:FEED 'EVM:EVCA'
TRACe:DATA?

**EVM vs Symbol**
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for each analyzed slot.

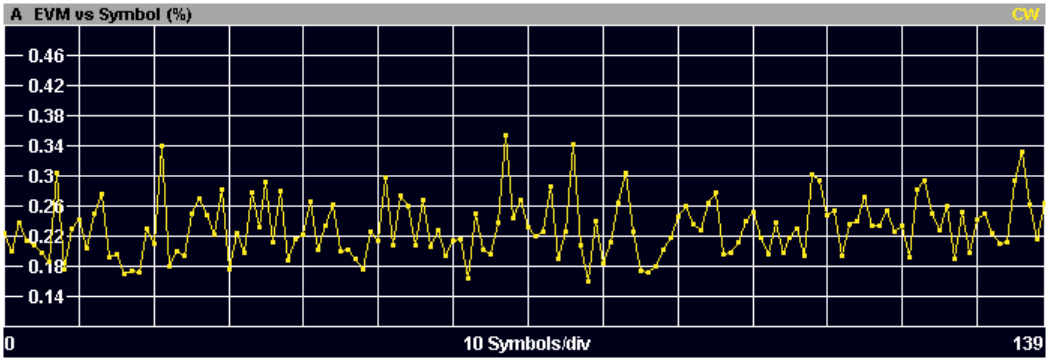
If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the OFDM symbol EVM averaged over all slots.
- Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed slots.
- Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the OFDM symbol EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 68

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSQ could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit




SCPI command:
CALCulate<n>:FEED 'EVM:EVSY'
TRACe:DATA?

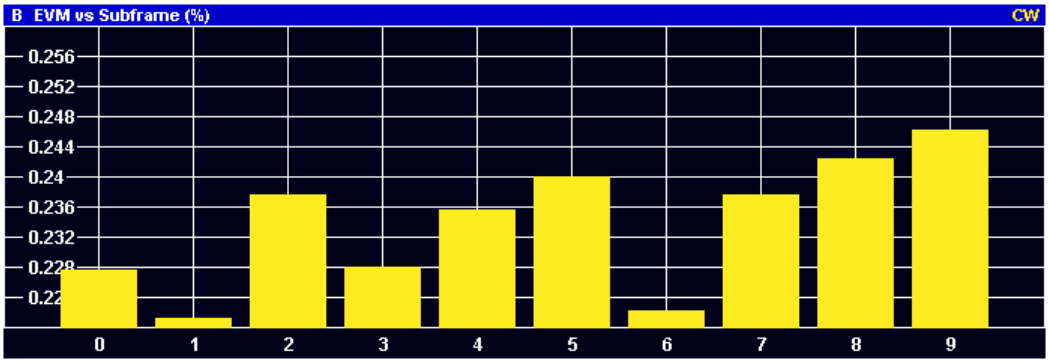
**EVM vs Subframe**
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.




SCPI command:
CALCulate<n>:FEED 'EVM:EVSU'
TRACe:DATA?

## 5.4 Measuring the Spectrum

This chapter contains information on all measurements that show the power of a signal in the frequency domain.

In addition to the I/Q measurements, spectrum measurements also include two frequency sweep measurements, the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio.

- Frequency Sweep Measurements....31
- I/Q Measurements....34

## 5.4.1 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Frequency sweep measurements are available if RF input is selected.

### 5.4.1.1 Available Measurements

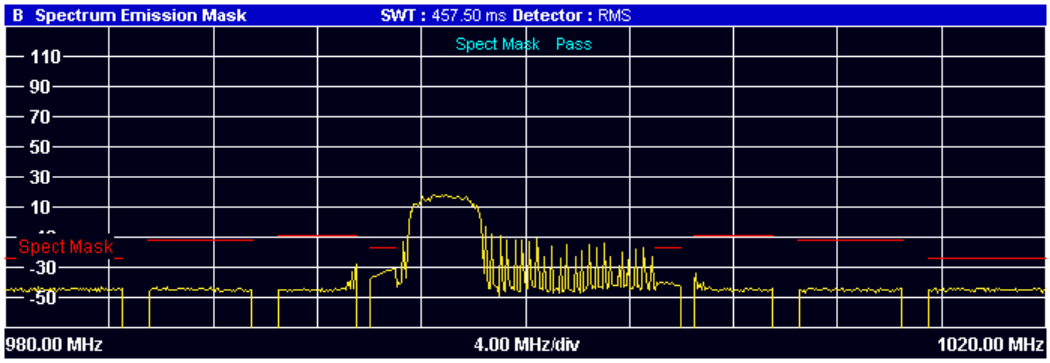
Spectrum Mask....31
ACLR....32

**Spectrum Mask**
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

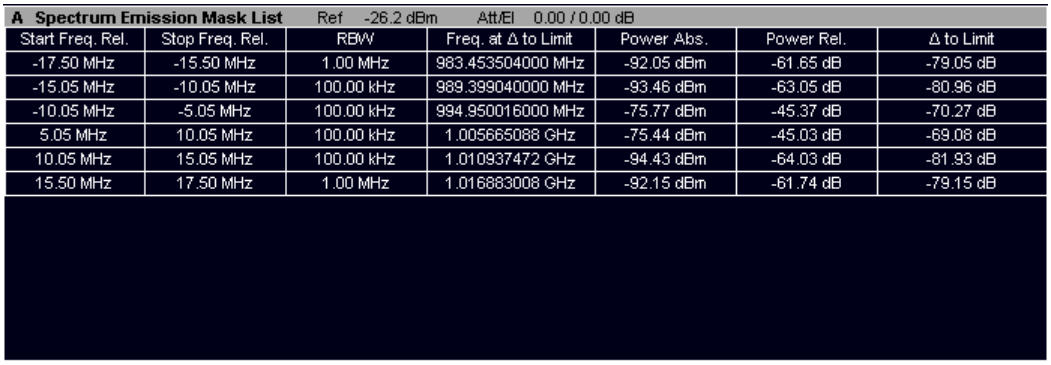
In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The R&S FSQ puts a label to the limit line to indicate whether the limit check passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.




A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.




| Start Freq. Rel. | Stop Freq. Rel. | RBW | Freq. at Δ to Limit | Power Abs. | Power Rel. | Δ to Limit |
|---|---|---|---|---|---|---|
| -17.50 MHz | -15.50 MHz | 1.00 MHz | 983.453504000 MHz | -92.05 dBm | -61.65 dB | -79.05 dB |
| -15.05 MHz | -10.05 MHz | 100.00 kHz | 989.399040000 MHz | -93.46 dBm | -63.05 dB | -80.96 dB |
| -10.05 MHz | -5.05 MHz | 100.00 kHz | 994.950016000 MHz | -75.77 dBm | -45.37 dB | -70.27 dB |
| 5.05 MHz | 10.05 MHz | 100.00 kHz | 1.005665088 GHz | -75.44 dBm | -45.03 dB | -69.08 dB |
| 10.05 MHz | 15.05 MHz | 100.00 kHz | 1.010937472 GHz | -94.43 dBm | -64.03 dB | -81.93 dB |
| 15.50 MHz | 17.50 MHz | 1.00 MHz | 1.016883008 GHz | -92.15 dBm | -61.74 dB | -79.15 dB |

SCPI command:
CALCulate<n>:FEED 'SPEC:SEM'
TRACe:DATA?

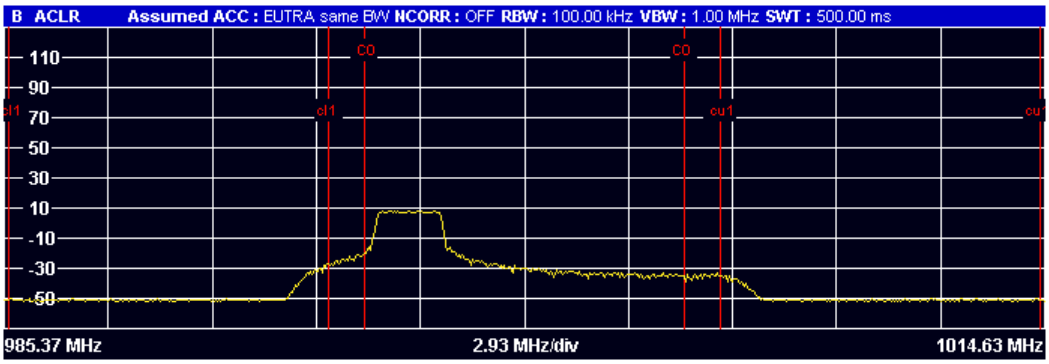
**ACLR**
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The Adjacent Channel Leakage Ratio measures the power of the TX channel and the power of adjacent and alternate channels to the left and right side of the TX channel. In this way, you can get information about the power of the channels adjacent to the transmission channel and the leakage into adjacent channels.

The results show the relative power measured in the two nearest channels either side of the transmission channel.

By default the ACLR settings are derived from the LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and the "Noise Correction" on page 48.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent bandwidths. On the y-axis, the power is plotted in dBm.




A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.

A ACLR List Ref 26.2 dBm Att/El 0.00 / 0.00 dB

| Channel | Bandwidth | Spacing | Lower | Upper | Limit |
|---|---|---|---|---|---|
| TX | 9.000 MHz | ... | | 19.73 dBm | ... |
| Adjacent | 9.000 MHz | 10.00 MHz | -41.85 dB | -46.74 dB | -29.20 dB |
| | ... | ... | ... | ... | ... |

SCPI command:
Selection:
CALCulate<n>:FEED 'SPEC:ACP'
Reading results:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?
on page 101
TRACe:DATA?

## 5.4.2 I/Q Measurements

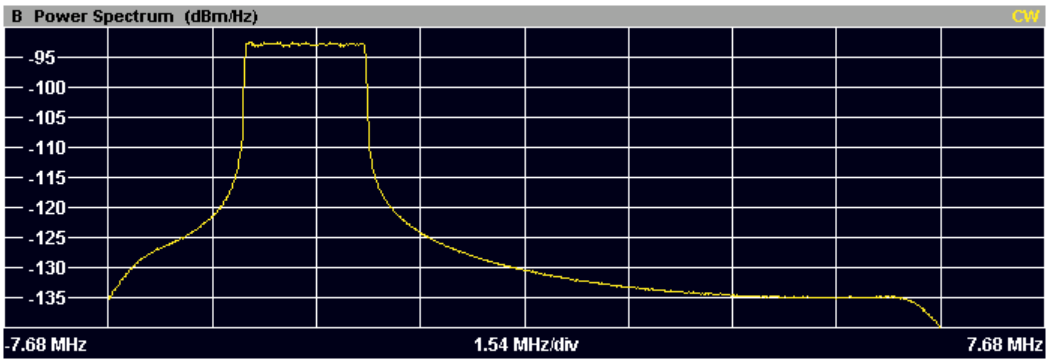
Power Spectrum....34
Inband Emission....34
Channel Flatness....35
Channel Group Delay....35
Channel Flatness Difference....36

**Power Spectrum**
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth / Number of Resource Blocks" on page 42.

The x-axis represents the frequency. On the y-axis the power level is plotted.



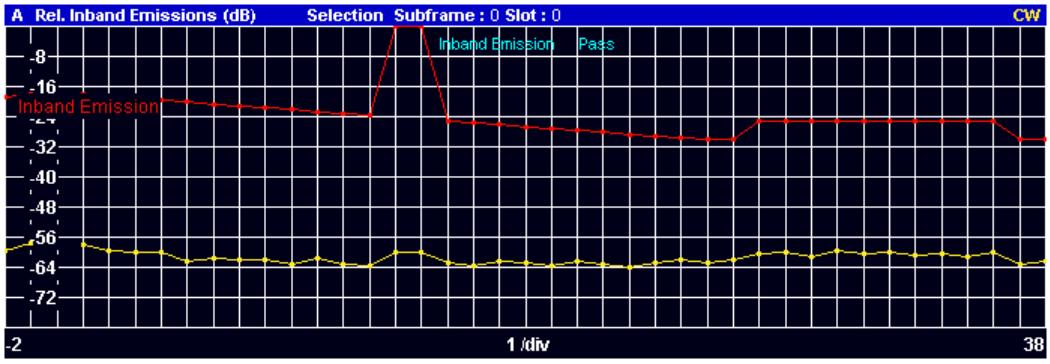

SCPI command:
CALCulate<screenid>:FEED 'SPEC:PSPE'
TRACe:DATA?

**Inband Emission**
Starts the Inband Emission result display.

This result display shows the relative power of the unused resource blocks (yellow trace) and the inband emission limit lines (red trace) specified by the LTE standard document 3GPP TS36.101.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection.

Note that you have to select a specific subframe and slot to get valid measurement results.




SCPI command:
CALCulate<screenid>:FEED 'SPEC:IE'
TRACe:DATA?

**Channel Flatness**
Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.

SCPI command:
CALCulate<n>:FEED 'SPEC:FLAT'
TRACe:DATA?

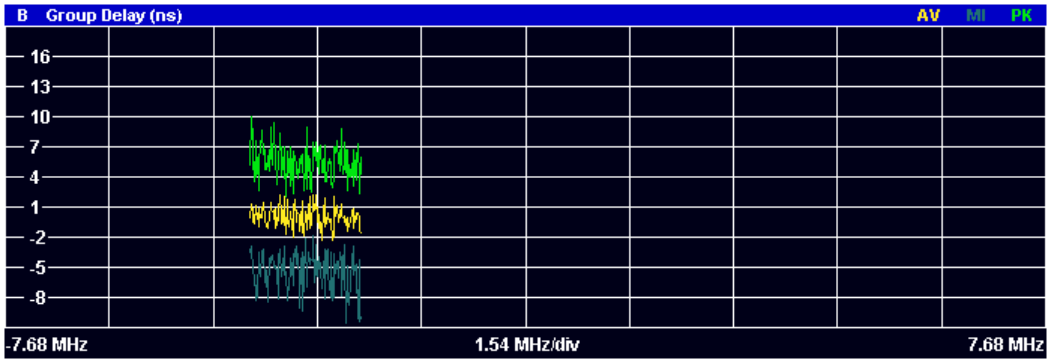
**Channel Group Delay**
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.




SCPI command:
CALCulate<n>:FEED 'SPEC:GDEL'
TRACe:DATA?

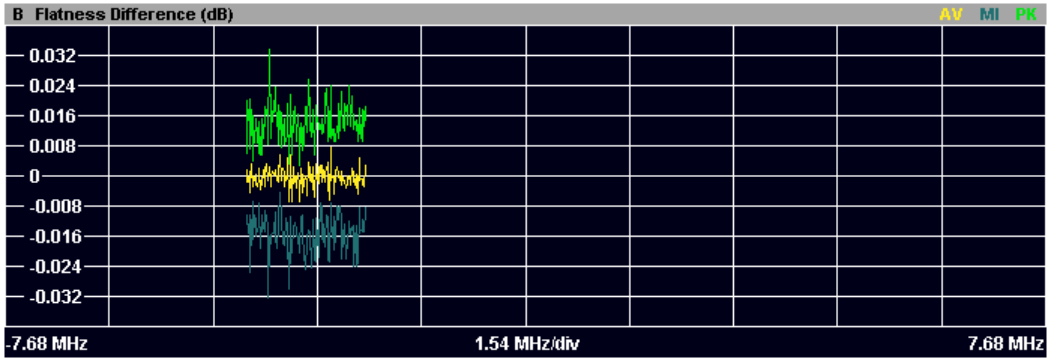
**Channel Flatness Difference**
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.




SCPI command:
CALCulate<n>:FEED 'SPEC:FDIF'
TRACe:DATA?

## 5.5 Measuring the Symbol Constellation

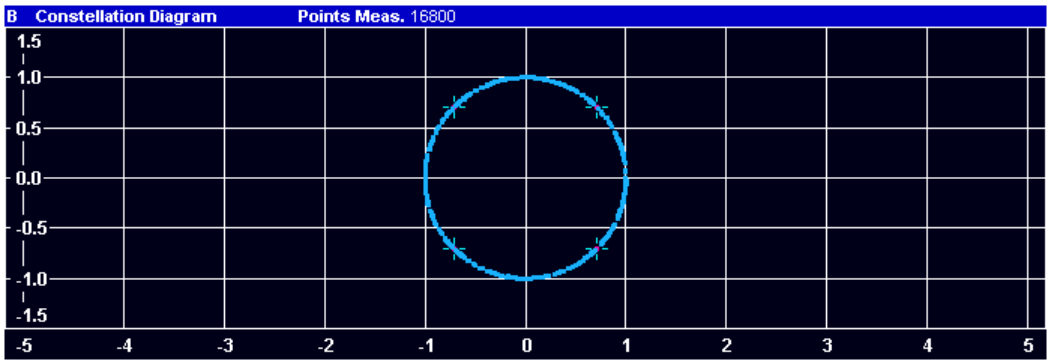
This chapter contains information on all measurements that show the constellation of a signal.

Constellation Diagram.....37

**Constellation Diagram**
Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.




SCPI command:
CALCulate<n>:FEED 'CONS:CONS'
TRACe:DATA?

## 5.6 Measuring Statistics

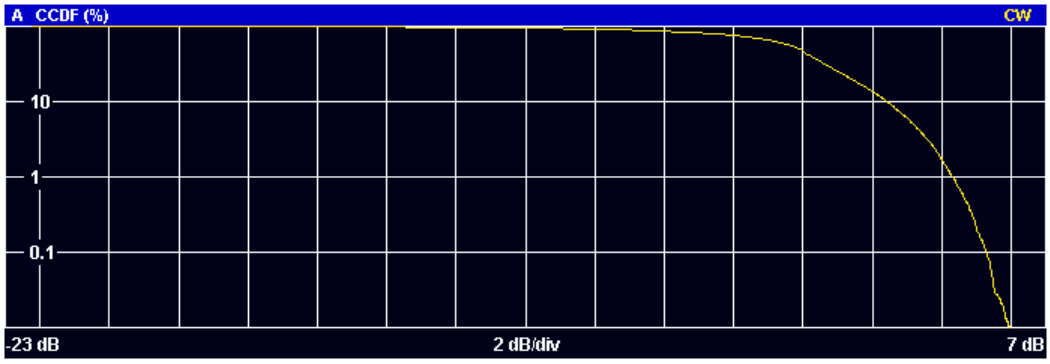
This chapter contains information on all measurements that show the statistics of a signal.

CCDF....37
Allocation Summary....38
Bit Stream....39

**CCDF**
Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

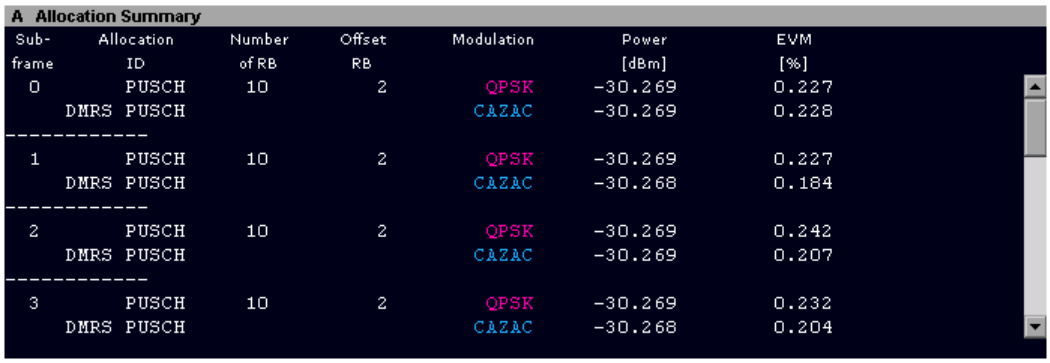
The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.




SCPI command:
CALCulate<n>:FEED 'STAT:CCDF'
TRACe:DATA?

**Allocation Summary**
Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.




The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Offset RB**
  Shows the resource block offset of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power**
  Shows the power of the allocation in dBm.
- **EVM**

Shows the EVM of the allocation. The unit depends on your selection.

SCPI command:
CALCulate<n>:FEED 'STAT:ASUM'
TRACe:DATA?

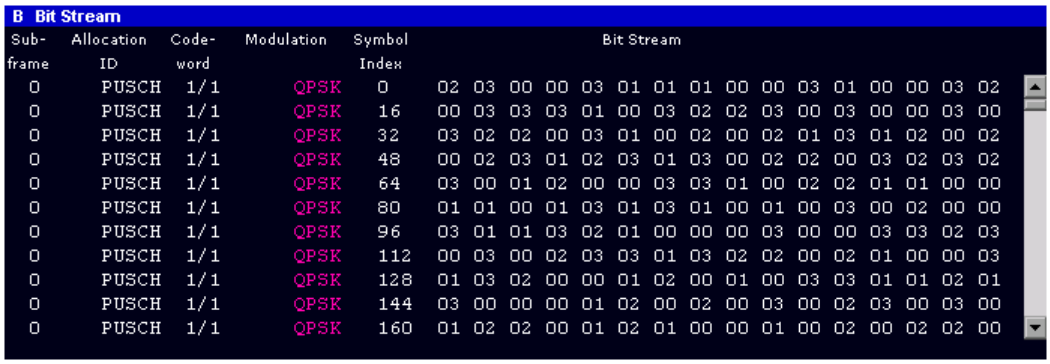
**Bit Stream**
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.




The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.
- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**
  Modulation type of the channels.
- **Symbol/Bit Index**
- **Bit Stream**
  The actual bit stream.

SCPI command:
CALCulate<n>:FEED 'STAT:BSTR'
TRACe:DATA?

# 6 Configuring and Performing the Measurement

Before you can start a measurement, you have to configure the R&S FSQ in order to get valid measurement results. This chapter contains detailed information on all settings available in the application.

You can access the two main settings dialog boxes via the "Settings (Gen Demod)" softkey. Pressing the softkey once opens the "General Settings" dialog box. The "Gen" label in the softkey turns green to indicate an active "General Settings" dialog box. Pressing the softkey again opens the "Demod Settings" dialog box. When the "Demod Settings" dialog box is active, the "Demod" label in the softkey turns green.

In the "General Settings" dialog box, you can set all parameters that are related to the overall measurement. The dialog box is made up of three tabs, one for general settings, one for MIMO settings and one for advanced settings. By default, the "General" tab is the active one.

In the "Demod Settings" dialog box you can set up the measurement in detail, e.g. the demodulation configuration. The dialog box is made up of three tabs, one for configuring the signal configuration, one for setting up the frame configuration and one for configuring the control channels and miscellaneous settings. By default, the "DL Demod" tab is the active one.

You can switch between the tabs with the cursor keys.


- Performing Measurements....40
- General Settings....41
- Configuring Spectrum Measurements....47
- Advanced General Settings....49
- Configuring Uplink Signal Demodulation....53
- Configuring Uplink Frames....56
- Defining Advanced Signal Characteristics....59


## 6.1 Performing Measurements

The sweep menu contains functions that control the way the R&S FSQ performs a measurement.

**Single Sweep and Continuous Sweep**
In continuous sweep mode, the R&S FSQ continuously captures data, performs measurements and updates the result display according to the trigger settings.

To activate single sweep mode, press the "Run Single" softkey. In single sweep mode, the R&S FSQ captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSQ interrupts the measurement.

You can always switch back to continuous sweep mode with the "Run Cont" softkey.

SCPI command:
`INITiate:CONTinuous` on page 82

**Auto Level**
The "Auto Level" softkey initiates a process that sets an ideal reference level for the current measurement.

For more information see "Defining a Reference Level" on page 43.

SCPI command:
`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 106

**Refresh**
Updates the current result display in single sweep mode without capturing I/Q data again.

If you have changed any settings after a single sweep and use the Refresh function, the R&S FSQ updates the current measurement results with respect to the new settings. It does not capture I/Q data again but uses the data captured last.

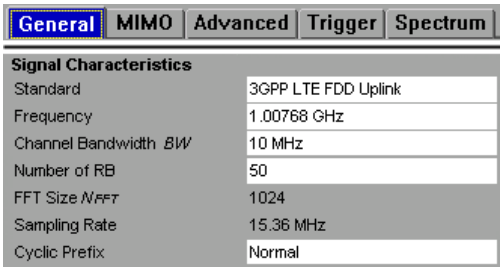
SCPI command:
`INITiate:REFResh` on page 83

## 6.2 General Settings

### 6.2.1 Defining Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal.

The signal characteristics are part of the "General" tab of the "General Settings" dialog box.




Selecting the LTE Mode....41
Defining the Signal Frequency....42
Channel Bandwidth / Number of Resource Blocks....42
Cyclic Prefix....43

**Selecting the LTE Mode**
The standard defines the LTE mode you are testing.

The choices you have depend on the configuration of the R&S FSQ.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K101(PC) enables testing of 3GPP LTE FDD signals on the uplink
- option FSx-K102(PC) enables testing of 3GPP LTE MIMO signals on the downlink
- option FSx-K104(PC) enables testing of 3GPP LTE TDD signals on the downlink
- option FSx-K105(PC) enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

SCPI command:

`CONFigure[:LTE]:LDIRection` on page 102

`CONFigure[:LTE]:DUPLexing` on page 102

**Defining the Signal Frequency**

For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The available frequency range depends on the hardware configuration of the analyzer you are using.

The frequency setting is available for the RF input source.

SCPI command:
Center frequency:

`[SENSe]:FREQuency:CENTer` on page 103

**Channel Bandwidth / Number of Resource Blocks**

Specifies the channel bandwidth and the number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. If you enter one, the R&S FSQ automatically calculates and adjusts the other.

Currently, the LTE standard recommends six bandwidths (see table below).

If you enter a value different to those recommended by the standard, the R&S FSQ labels the parameter as "User", but still does the calculations.

The R&S FSQ also calculates the FFT size and sampling rate from the channel bandwidth. Those are read only.

| Channel Bandwidth [MHz] | 1.4 | 3 | 5 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|
| Number of Resource Blocks | 6 | 15 | 25 | 50 | 75 | 100 |
| Sample Rate [MHz] | 1.92 | 3.84 | 7.68 | 15.36 | 23.04 | 30.72 |
| FFT Size | 128 | 256 | 512 | 1024 | 2048 | 2048 |

SCPI command:
`CONFigure[:LTE]:UL:BW` on page 103
`CONFigure[:LTE]:UL:NORB` on page 103

**Cyclic Prefix**
The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

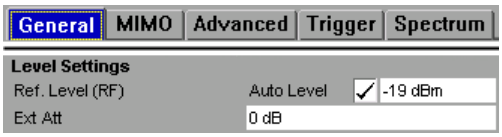
- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

SCPI command:
`CONFigure[:LTE]:UL:CYCPrefix` on page 103

## 6.2.2 Configuring the Input Level

The level settings contain settings that control the input level of the analyzer.

The level settings are part of the "General" tab of the "General Settings" dialog box.




Defining a Reference Level....43
Attenuating the Signal....44

**Defining a Reference Level**
The reference level is the power level the R&S FSQ expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the **RF Reference Level** (in dBm) or **Baseband Reference Level** (in V), depending on the input source.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value before each sweep. This process slightly increases the measurement time. You can define the measurement time of that measurement with the **Auto Level Track Time**.

Automatic level detection also optimizes RF attenuation.

SCPI command:
Manual (RF):
`CONFigure:POWer:EXPected:RF<analyzer>` on page 104
Manual (BB):
`CONFigure:POWer:EXPected:IQ<analyzer>` on page 104
Automatic:
`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 106
Auto Level Track Time:
`[SENSe]:POWer:AUTO<analyzer>:TIME` on page 106

**Attenuating the Signal**
Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

The LTE application provides several attenuation modes.

- **External** attenuation is always available. It controls an external attenuator if you are using one.
- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.
  Mechanical attenuation is available in the "Advanced" tab of the "General Settings" dialog box.
- If you have equipped your R&S FSQ with option R&S FSQ-B25, it also provides **electronic** attenuation. Note that the frequency range may not exceed the specification of the electronic attenuator for it to work.
  Electronic attenuation is available in the "Advanced" tab of the "General Settings" dialog box.

Positive values correspond to an attenuation and negative values correspond to an amplification.

RF attenuation is independent of the reference level. It is available if automatic reference level detection is inactive. The range is from 0 dB to 75 dB.

The process of configuring the electronic attenuator consists of three steps.

- Selecting the mode
  You can select either manual or automatic control of the electronic attenuator.
- Selecting the state
  Turns the electronic attenuator on and off.
- Setting the attenuation level
  Sets the degree of electronic attenuation.

If you have selected automatic attenuation, the R&S FSQ automatically calculates the electronic attenuation. State and degree of attenuation are not available in that case.

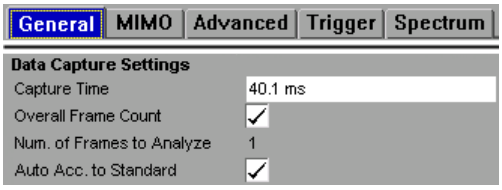
If you turn the electronic attenuator off, the degree of attenuation is not available.

SCPI command:
RF attenuation:
`INPut<n>:ATTenuation<analyzer>` on page 105
External attenuation:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 104
Electronic attenuation:
`INPut<n>:EATT:STATe` on page 105
`INPut<n>:EATT:AUTO` on page 105
`INPut<n>:EATT` on page 105

### 6.2.3 Configuring the Data Capture

The data capture settings contain settings that control the amount of data and the way that the application records the LTE signal.

The data capture settings are part of the "General" tab of the "General Settings" dialog box.




Capture Time....45
Overall Frame Count....46
Number of Frames to Analyze....46
Auto According to Standard....46

**Capture Time**
Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the application captures during one sweep.

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

SCPI command:
`[SENSe]:SWEep:TIME` on page 107

**Overall Frame Count**
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the R&S FSQ analyzes all complete LTE frames currently in the capture buffer.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:STATe` on page 107

**Number of Frames to Analyze**
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FSQ continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt` on page 106

**Auto According to Standard**
Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FSQ evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

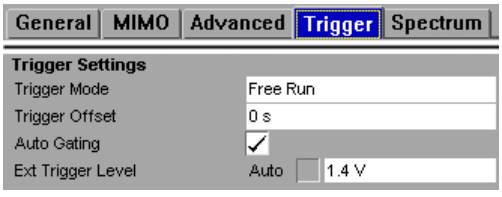
This parameter is not available if the overall frame count is inactive.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:AUTO` on page 107

### 6.2.4 Triggering Measurements

The trigger settings contain settings that control triggered measurements.

The trigger settings are part of the "Trigger" tab of the "General Settings" dialog box.




For more information also see Auto Gating in the "Spectrum" tab of the "General Settings" dialog box.

Configuring the Trigger.....47

**Configuring the Trigger**
A trigger allows you to capture those parts of the signal that you are really interested in.

While the R&S FSQ runs freely and analyzes all signal data in its default state, no matter if the signal contains information or not, a trigger initiates a measurement only under certain circumstances (the trigger event).

The R&S FSQ supports several **trigger modes** or sources.

- Free Run
  Starts the measurement immediately and measures continuously.
- External
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/Gate" input.
- IF Power
  The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.

You can define a **power level** for an external and an IF power trigger.

The name and contents of the Power Level field depend on the selected trigger mode. It is available only in combination with the corresponding trigger mode.

The measurement starts as soon as the trigger event happens. It may become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset** (or trigger delay). The trigger offset is the time that should pass between the trigger event and the start of the measurement.

The trigger offset may be a negative time. The trigger offset is then called a **pretrigger**.

The trigger offset is available for all trigger modes, except free run.

SCPI command:
Trigger mode:
`TRIGger[:SEQuence]:MODE` on page 109
Trigger level:
`TRIGger[:SEQuence]:LEVel<analyzer>:POWer` on page 109
Trigger offset:
`TRIGger[:SEQuence]:HOLDoff<analyzer>` on page 108

## 6.3 Configuring Spectrum Measurements

The Spectrum settings contain parameters to configure spectrum measurements (ACLR and SEM) in particular.

### 6.3.1 Configuring SEM Measurements

The SEM settings are part of the "Spectrum" tab of the "General Settings" dialog box.

Category....48

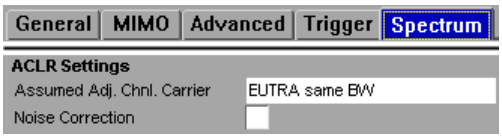
**Category**
Selects the limit definitions for SEM measurements.

Category A and B are defined in ITU-R recommendation SM.329. The category you should use for the measurement depends on the category that the base station you are testing supports.

SCPI command:
`[SENSe]:POWer:SEM:CATegory` on page 82

### 6.3.2 Configuring ACLR Measurements

The ACLR settings are part of the "Spectrum" tab of the "General Settings" dialog box.




Assumed Adjacent Channel Carrier....48
Noise Correction....48

**Assumed Adjacent Channel Carrier**
Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

SCPI command:
`[SENSe]:POWer:ACHannel:AACHannel` on page 81

**Noise Correction**
Turns noise correction on and off.

For more information see the manual of the R&S FSQ.

Note that the input attenuator makes a clicking noise after each sweep if you are using the noise correction in combination with the auto leveling process.

SCPI command:
`[SENSe]:POWer:NCORrection` on page 81

### 6.3.3 Configuring Gated Measurements

The gate settings settings are part of the "Spectrum" tab of the "General Settings" dialog box.

Auto Gating.....49

**Auto Gating**
Turns gating for SEM and ACLR measurements on and off.

If on, the software evaluates the on-periods of an LTE TDD signal only. The software determines the location and length of the on-period from the "TDD UL/DL Allocations" and the "Configuration of the Special Subframe".

Auto gating is available for TDD measurements in combination with an external or IF power trigger.

If you are using an external trigger, the DUT has to send an LTE frame trigger.

SCPI command:
`[SENSe]:SWEep:EGATe:AUTO` on page 82

## 6.4 Advanced General Settings

The "Advanced" settings contain parameters to configure more complex measurement setups.

### 6.4.1 Controlling I/Q Data

The I/Q settings contain settings that control the I/Q data flow.

The I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

Swap I/Q.....49

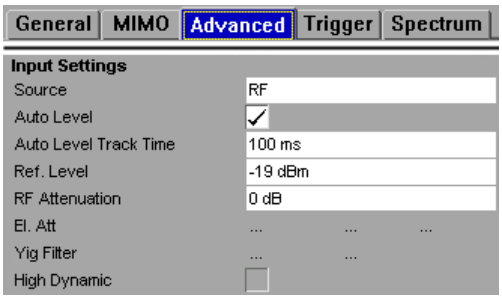
**Swap I/Q**
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

SCPI command:
`[SENSe]:SWAPiq` on page 109

### 6.4.2 Controlling the Input

The input settings contain settings that control the input source.

The input settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.




For more information on reference level see "Defining a Reference Level" on page 43.

For more information on signal attenuation see "Attenuating the Signal" on page 44.

Selecting the Input Source....50
Yig Filter....50
High Dynamic....51

**Selecting the Input Source**
The input source selects the source of the data you'd like to analyze. You can either analyze a live signal or a signal that has been recorded previously and whose characteristics have been saved to a file.

You can select the input source from the "Source" dropdown menu.

- RF
  Captures and analyzes the data from the RF input of the spectrum analyzer in use.
- Baseband (BB)
  Captures and analyzes the data from the baseband input of the spectrum analyzer in use.
  The analog baseband input is available with option R&S FSQ-B71.
- Digital I/Q
  Captures and analyzes the data from the digital baseband input of the spectrum analyzer in use.
  The digital baseband input is available with option R&S FSQ-B17.

For more information on using hardware options R&S FSQ-B17 and -B71 see the manual of the R&S FSQ.

SCPI command:
`INPut:SELect` on page 110

**Yig Filter**
Configures the YIG filter.

If you want to measure broadband signals, you can configure the YIG filter for a greater bandwidth.

The process of configuring the YIG filter consist of two steps.

- **Selecting the mode**
  You can select either manual or automatic control of the YIG filter.
- **Selecting the state**
  Turns the YIG filter on and off.
  If inactive, you can use the maximum bandwidth. However, image frequency rejection is no longer ensured.

If you have selected automatic YIG filter control, the R&S FSQ automatically resolves whether to use the YIG filter or not. Manual selection of the YIG filter state is not available in that case.

Note that the R&S FSQ uses the YIG filter only for frequencies greater than 3.6 GHz. If the frequency is smaller, these settings have no effect.

SCPI command:
`INPut<n>:FILTer:YIG[:STATe]` on page 110
`INPut<n>:FILTer:YIG:AUTO` on page 110

**High Dynamic**
Turns the bypass of the bandwidth extension R&S FSQ-B72 on and off if you are using a wideband filter. The signal instead passes through the normal signal path.

If active, high dynamic results in a higher resolution because the normal signal path uses a 14-bit ADC. However, all signals to the left or right of the spectrum of interest are folded into the spectrum itself.

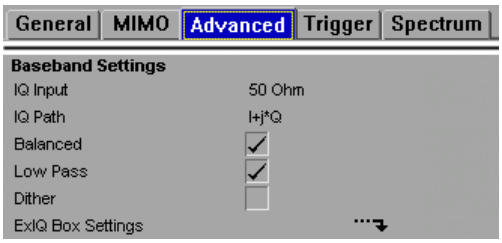
The high dynamic functionality is available only if R&S FSQ-B72 is installed and the sample rate is in the range from 20.4 MHz to 40.8 MHz.

SCPI command:
`TRACe:IQ:FILTer:FLATness` on page 111

## 6.4.3 Configuring the Baseband Input

The baseband settings contain settings that configure the baseband input.

The baseband settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.




I/Q Input....52
I/Q Path....52
Balanced....52
Low Pass....52
Dither....52

**I/Q Input**
Selects the impedance of the baseband inputs.

Depending on the configuration of the baseband input, you can select an impedance of 50 Ω and 1 k Ω or 1 M Ω.

The I/Q input is available only if you have selected a baseband input source.

SCPI command:
`INPut:IQ:IMPedance` on page 111

**I/Q Path**
Selects the input path for baseband inputs.

You can either select a single input (I or Q) or a dual input (I and Q).

If you are using single input, swapping the I and Q branches becomes unavailable.

The I/Q path selection is available only if you have selected a baseband input source.

SCPI command:
`INPut:IQ:TYPE` on page 112

**Balanced**
Turns symmetric (or balanced) input on and off.

If active, a ground connection is not necessary. If you are using an assymetrical (unbalanced) setup, the ground connection runs through the shield of the coaxial cable that is used to connect the DUT

Balancing is available for a baseband input source.

SCPI command:
`INPut:IQ:BALanced[:STATe]` on page 111

**Low Pass**
Turns an anti-aliasing low pass filter on and off.

The filter has a cut-off frequency of 36 MHz and prevents frequencies above from being mixed into the usable frequency range. Note that if you turn the filter off, harmonics or spurious emissions of the DUT might be in the frequency range above 36 MHz and might be missed.

You can turn it off for measurement bandwidths greater than 30 MHz.

The low pass filter is available for a baseband input source.

SCPI command:
`[SENSe]:IQ:LPASs[:STATe]` on page 112

**Dither**
Adds a noise signal into the signal path of the baseband input.

Dithering improves the linearity of the A/D converter at low signal levels or low modulation. Improving the linearity also improves the accuracy of the displayed signal levels.

The signal has a bandwidth of 2 MHz with a center frequency of 38.93 MHz.

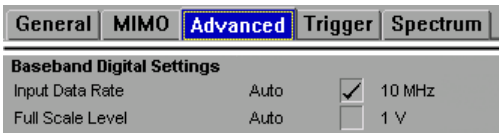
Dithering is available for a baseband input source.

SCPI command:
`[SENSe]:IQ:DITHer[:STATe]` on page 112

### 6.4.4 Configuring the Digital I/Q Input

The digital I/Q settings contain settings that configure the digital I/Q input.

The digital I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.




Sampling Rate (Input Data Rate).....53
Full Scale Level.....53

**Sampling Rate (Input Data Rate)**
Defines the data sample rate at the digital baseband input.

The sample rate is available for a digital baseband input source.

SCPI command:
`INPut<n>:DIQ:SRATe` on page 112

**Full Scale Level**
Defines the voltage corresponding to the maximum input value of the digital baseband input.

SCPI command:
`INPut<n>:DIQ:RANGe[:UPPer]` on page 113

## 6.5 Configuring Uplink Signal Demodulation

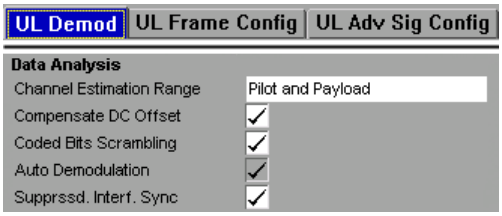
The uplink demodulation settings contain settings that describe the signal processing and the way the signal is measured.

You can find the demodulation settings in the "Demod Settings" dialog box.

### 6.5.1 Configuring the Data Analysis

The data analysis settings contain setting that control the data analysis.

The data analysis settings are part of the "Uplink Demodulation Settings" tab of the "Demodulation Settings" dialog box.



Channel Estimation Range....54
Compensate DC Offset....54
Scrambling of Coded Bits....54
Auto Demodulation....54
Suppressed Interference Synchronization....55

**Channel Estimation Range**
Selects the method for channel estimation.

Choose whether to use only the pilot symbols to perform channel estimation or both pilot and payload carriers.

SCPI command:
`[SENSe][:LTE]:UL:DEMod:CESTimation` on page 114

**Compensate DC Offset**
Activates or deactivates DC offset compensation when calculating measurement results.

According to 3GPP TS 36.101 (Annex F.4), the R&S FSQ removes the carrier leakage (I/Q origin offset) from the evaluated signal before it calculates the EVM and in-band emissions.

SCPI command:
`[SENSe][:LTE]:UL:DEMod:CDCoffset` on page 114

**Scrambling of Coded Bits**
Turns the scrambling of coded bits for the PUSCH on and off.

The scrambling of coded bits affects the bitstream results.

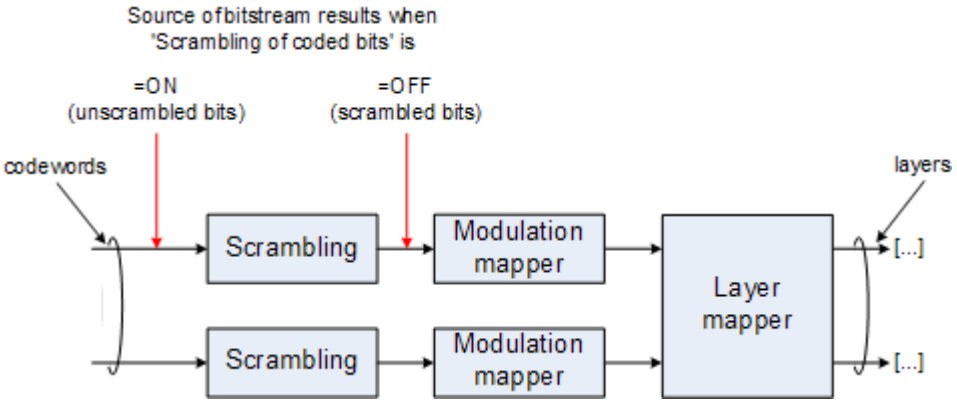



*Fig. 6-1: Source for bitstream results if scrambling for coded bits is on and off*

SCPI command:
`[SENSe][:LTE]:UL:DEMod:CBSCrambling` on page 113

**Auto Demodulation**
Turns automatic demodulation on and off.

If active, the R&S FSQ automatically detects the resource allocation of the signal.

Automatic demodulation is not available if the suppressed interference synchronization is active.

SCPI command:
[SENSe][:LTE]:UL:DEMod:AUTO on page 113

**Suppressed Interference Synchronization**
Turns suppressed interference synchronization on and off.

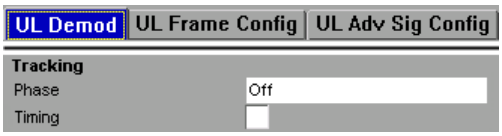
If active, the synchronization on signals containing more than one user equipment (UE) is more robust. Additionally, the EVM is lower in case the UEs have different frequency offsets. Note that Auto Demodulation is not supported in this synchronization mode and the EVM may be higher in case only one UE is present in the signal.

SCPI command:
[SENSe][:LTE]:UL:DEMod:SISYnc on page 114

## 6.5.2 Compensating Measurement Errors

The tracking settings contain settings that compensate for various common measurement errors that may occur.

The tracking settings are part of the "Uplink Demodulation Settings" tab of the "Demodulation Settings" dialog box.




Phase....55
Timing....55

**Phase**
Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

| | |
|---|---|
| "Off" | Phase tracking is not applied. |
| "Pilot Only" | Only the reference signal is used for the estimation of the phase error. |
| "Pilot and Payload" | Both reference signal and payload resource elements are used for the estimation of the phase error. |

SCPI command:
[SENSe][:LTE]:UL:TRACking:PHASe on page 114

**Timing**
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

SCPI command:
[SENSe][:LTE]:UL:TRACking:TIME on page 115

# 6.6 Configuring Uplink Frames

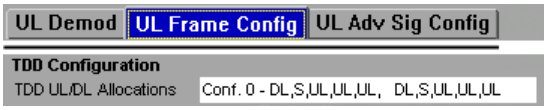
The frame configuration contains settings that define the structure of the uplink LTE signal.

You can find the frame structure in the "Demod Settings" dialog box.

## 6.6.1 Configuring TDD Signals

The TDD settings define the characteristics of an LTE TDD signal.

The TDD settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.




Configuring TDD Frames.....56

**Configuring TDD Frames**
TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

**TDD UL/DL Allocations**

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

| Configuration | Subframe Number and Usage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | D | S | U | U | U | D | S | U | U | U |
| 1 | D | S | U | U | D | D | S | U | U | D |
| 2 | D | S | U | D | D | D | S | U | D | D |
| 3 | D | S | U | U | U | D | D | D | D | D |
| 4 | D | S | U | U | D | D | D | D | D | D |
| 5 | D | S | U | D | D | D | D | D | D | D |
| 6 | D | S | U | U | U | D | S | U | U | D |

U = uplink
D = downlink
S = special subframe

**Conf. of Special Subframe**

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.

- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

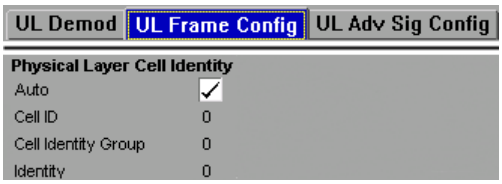
The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

SCPI command:
Subframe
`CONFigure[:LTE]:UL:TDD:UDConf` on page 115
Special Subframe
`CONFigure[:LTE]:UL:TDD:SPSC` on page 115

### 6.6.2 Configuring the Physical Layer Cell Identity

The physical signal characteristics contain settings to describe the phyiscal attributes of an LTE signal.

The physical settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.




Configuring the Physical Layer Cell Identity.....57

**Configuring the Physical Layer Cell Identity**
The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the R&S FSQ automatically updates the other two.

The Cell ID determines

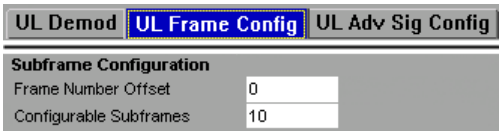
- the reference signal grouping hopping pattern
- the reference signal sequence hopping
- the PUSCH demodulation reference signal pseudo-random sequence
- the cyclic shifts for PUCCH formats 1/1a/1b and sequences for PUCCH formats 2/2a/2b
- the pseudo-random sequence used for scrambling
- the pseudo-random sequence used for type 2 PUSCH frequency hopping

SCPI command:
Cell ID:
`CONFigure[:LTE]:UL:PLC:CID` on page 116
Cell Identity Group:
`CONFigure[:LTE]:UL:PLC:CIDGroup` on page 116
Identity
`CONFigure[:LTE]:UL:PLC:PLID` on page 116

### 6.6.3 Configuring Subframes

The application allows you to configure individual subframes.

If you turn "Auto Demodulation" on, the appplication automatically determines the subframe configuration. In the default state, automatic configuration is on.




An LTE frame contains 10 subframes. The R&S FSQ shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one subframe.

You can also define a frame number offset that the software uses to demodulate the captured frame.

| Subframe | Enable PUCCH | Modulation | Number of RB | Offset RB | Power [dB] |
|---|---|---|---|---|---|
| 0 (not used) | | | | | |
| 1 (not used) | | | | | |
| 2 | | QPSK | 1 | 0 | 0 dB |
| 3 | | QPSK | 1 | 0 | 0 dB |
| 4 | | QPSK | 1 | 0 | 0 dB |
| 5 (not used) | | | | | |
| 6 (not used) | | | | | |
| 7 | | QPSK | 1 | 0 | 0 dB |
| 8 | | QPSK | 1 | 0 | 0 dB |
| 9 | | QPSK | 1 | 0 | 0 dB |

Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 10 subframes.

Configuring Subframes.....59

**Configuring Subframes**
According to the number of configurable subframes you have set, the R&S FSQ adjusts the size of the subframe configuration table. Each row in the table corresponds to one allocation if the subframe is a cluster. Else, the row is a subframe.

The configuration table contains the settings to configure the subframes.

- Subframe
  Shows the number of a subframe.
  Note that, depending on the configuration, some subframes may not be available for editing. The R&S FSQ labels those downlink subframes "(not used)". The corresponding cells in the table are greyed out.
- Enable PUCCH
  Turns the PUCCH in the corresponding subframe on and off.
  If you turn on a PUCCH, "Modulation", "Number of RBs" and "Offset RB" are unavailable for that subframe.
- Modulation
  Selects the modulation scheme for the corresponding PUSCH allocation.
  The modulation scheme is either QPSK, 16QAM or 64QAM.
- Number of RB
  Sets the number of resource blocks the PUSCH allocation covers. The number of resource blocks defines the size or bandwidth of the PUSCH allocation.
- Offset RB
  Sets the resource block at which the PUSCH allocation begins.

SCPI command:
Configurable subframes:
`CONFigure[:LTE]:UL:CSUBframes` on page 117
Frame number offset:
`CONFigure[:LTE]:UL:SFNO` on page 117
Enable PUCCH:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT` on page 118
Modulation:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation` on page 118
Number of RB:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount` on page 117
Offset RB:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset` on page 117

## 6.7 Defining Advanced Signal Characteristics

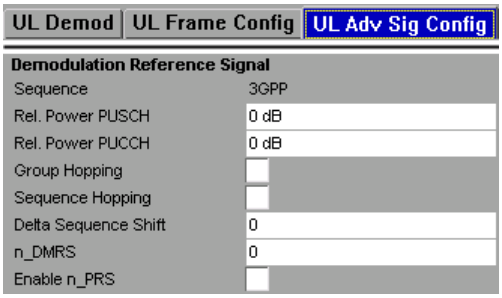
The uplink advanced signal characteristics contain settings that describe the detailed structure of a uplink LTE signal.

You can find the advanced signal characteristics in the "Demod Settings" dialog box.

### 6.7.1 Configuring the Demodulation Reference Signal

The demodulation reference signal settings contain settings that define the physical attributes and structure of the demodulation reference signal. This reference signal helps to demodulate the PUSCH.

The demodulation reference signal settings are part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.




Sequence....60
Relative Power PUSCH....60
Relative Power PUCCH....60
Group Hopping....61
Sequence Hopping....61
Delta Sequence Shift....61
n(1)_DMRS....61
Enable n_PRS....61

**Sequence**
Selects the definition the demodulation reference signal is based on.

"3GPP" The structure of the DRS is based on the 3GPP standard.
If you are using a DRS based on 3GPP, you have to set all parameters in the "Demodulation Reference Signal" settings group. They have to be the same as those of the signal generator.

**Relative Power PUSCH**
Sets the power offset of the Demodulation Reference Signal (DRS) relative to the power level of the PUSCH allocation of the corresponding subframe. The selected DRS power offset (PDRS_Offset) applies for all subframes. Depending on the allocation of the subframe, the effective power level of the DRS is calculated as following:

$P_{DRS}=P_{UE}+P_{PUSCH}+P_{DRS_Offset}$

The PUSCH Power level ($P_{PUSCH}$) can vary per subframe.

SCPI command:
`CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer` on page 120

**Relative Power PUCCH**
Sets the power offset of the Demodulation Reference Signal (DRS) relative to the power level of the PUCCH allocation of the corresponding subframe. The selected DRS power offset ($P_{DRS_Offset}$) applies for all subframes. Depending on the allocation of the subframe, the effective power level of the DRS is calculated as following:

$P_{DRS}=P_{UE}+P_{PUCCH}+P_{DRS_Offset}$ (for PUCCH allocation)

The PUCCH Power level ($P_{PUCCH}$) can vary per subframe.

SCPI command:
`CONFigure[:LTE]:UL:DRS:PUCCh:POWer` on page 119

**Group Hopping**
Indicates whether group hopping for the demodulation reference signal is activated or not.

17 different hopping patterns and 30 different sequence shift patterns are used for group hopping. PUSCH and PUCCH use the same group hopping pattern that is calculated if the group hopping is enabled. The group hopping pattern is generated by a pseudo-random sequence generator.

SCPI command:
`CONFigure[:LTE]:UL:DRS:GRPHopping` on page 119

**Sequence Hopping**
Turns sequence hopping for the uplink demodulation reference signal on and off.

Sequence hopping is generated by a pseudo-random sequence generator.

SCPI command:
`CONFigure[:LTE]:UL:DRS:SEQHopping` on page 120

**Delta Sequence Shift**
Delta Sequence Shift specifies the parameter $\Delta_{SS}$

This parameter can be found in 3GPP TS 36.211 V8.5.0, 5.5.1.3 Group hopping. A sequence shift function f_ss is defined for the PUCCH. The corresponding function for the PUSCH is derived by applying this Delta Sequence Shift.

SCPI command:
`CONFigure[:LTE]:UL:DRS:DSSHift` on page 119

**n(1)_DMRS**
The n_DMRS parameter can be found in 3GPP TS36.211 V8.5.0, 5.5.2.1.1 Reference signal sequence.

Currently, n_DMRS is defined as n_DMRS = $n_{DMRS}^{(1)}+n_{DMRS}^{(2)}$ .

SCPI command:
`CONFigure[:LTE]:UL:DRS:NDMRs` on page 119

**Enable n_PRS**
Enables the use of the pseudo-random sequence n_PRS in the calculation of the demodulation reference signal (DMRS) index as defined in 3GPP TS 36.211, chapter 5.5.2.1.1.

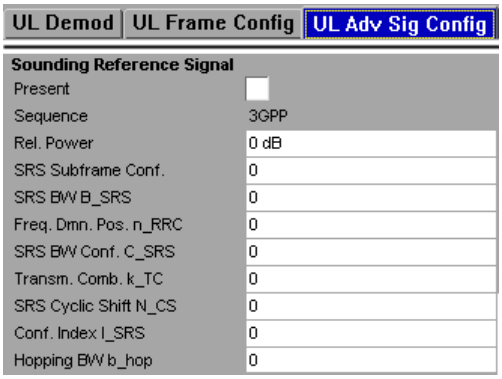
If n_PRS is disabled, it is possible to set the cyclic shift to 0 for all subframes.

This parameter has to be enabled in order to generate a 3GPP compliant uplink signal.

### 6.7.2 Configuring the Sounding Reference Signal

The sounding reference signal settings contain settings that define the physical attributes and structure of the sounding reference signal.

The sounding reference signal settings are part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

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SRS Bandwidth B_SRS....63
Freq. Domain Pos. n_RRC....63
SRS BW Conf. C_SRS....63
Transm. Comb. k_TC....63
SRS Cyclic Shift N_CS....63
Conf. Index I_SRS....64
Hopping BW b_hop....64

**Present**
Indicates whether the sounding reference signal is present or not.

SCPI command:
`CONFigure[:LTE]:UL:SRS:STAT` on page 122

**SRS Rel Power**
Defines the power offset of the sounding reference signal.

The power offset is relative to the power of the corresponding UE and applies to all subframes.

The effective power level of the SRS is thus

$P_{SRS} = P_{UE} + P_{SRS_Offset}$

SCPI command:
`CONFigure[:LTE]:UL:SRS:POWer` on page 122

**SRS Subframe Conf.**
Sets the cell specific parameter SRS subframe configuration. The UEs will send shortened PUSCH/PUCCH in these cell-specific subframes, regardless whether the UEs are configured to send a SRS in the according subframe or not.

SCPI command:
`CONFigure[:LTE]:UL:SRS:SUConfig` on page 122

**SRS Bandwidth B_SRS**
Sets the UE specific parameter SRS Bandwidth $B_{SRS}$, as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

The SRS either spans the entire frequency bandwidth or employs frequency hopping where several narrowband SRS cover the same total bandwidth.

There are up to four SRS bandwidths defined in the standard. The most narrow SRS bandwidth ($B_{SRS}$ = 3) spans four resource blocks and is available for all channel bandwidths; the other three values of the parameter $B_{SRS}$ define more wideband SRS bandwidths, available depending on the channel bandwidth.

The SRS transmission bandwidth is determined additionally by the SRS Bandwidth Configuration $C_{SRS}$.

SCPI command:
`CONFigure[:LTE]:UL:SRS:BSRS` on page 121

**Freq. Domain Pos. n_RRC**
Sets the UE specific parameter Freq. Domain Position $n_{RRC}$ , as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

This parameter determines the starting physical resource block of the SRS transmission.

SCPI command:
`CONFigure[:LTE]:UL:SRS:NRRC` on page 121

**SRS BW Conf. C_SRS**
Sets the cell specific parameter SRS Bandwidth Configuration ($C_{SRS}$).

The SRS Bandwidth Configuration $C_{SRS}$, the SRS Bandwidth $B_{SRS}$ and the UL Channel Bandwidth determine the length of the sounding reference signal sequence, calculated according to 3GPP TS 36.211.

SCPI command:
`CONFigure[:LTE]:UL:SRS:CSRS` on page 121

**Transm. Comb. k_TC**
Sets the UE specific parameter transmission comb $k_{TC}$, as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

SCPI command:
`CONFigure[:LTE]:UL:SRS:TRComb` on page 122

**SRS Cyclic Shift N_CS**
Sets the cyclic shift n_CS used for the generation of the sounding reference signal CAZAC sequence.

Since the different shifts of the same Zadoff-Chu sequence are orthogonal to each other, applying different SRS cyclic shifts can be used to schedule different users to transmit simultaneously their sounding reference signal.

SCPI command:
CONFigure[:LTE]:UL:SRS:CYCS on page 121

**Conf. Index I_SRS**
Sets the UE specific parameter SRS configuration index $I_{SRS}$. Depending on the selected Duplexing Mode, this parameter determines the parameters SRS Periodicity $T_{SRS}$ and SRS Subframe Offset $T_{offset}$ as defined in the 3GPP TS 36.213, Table 8.2-1 (FDD) and 8.2-2 (TDD) respectively.

SCPI command:
CONFigure[:LTE]:UL:SRS:ISRS on page 121

**Hopping BW b_hop**
Sets the UE specific parameter frequency hopping bandwidth $b_{hop}$, as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

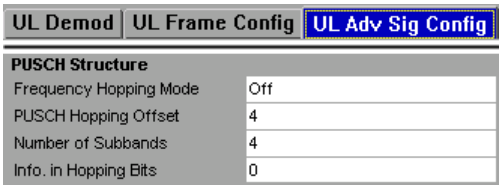
SRS frequency hopping is enabled, if $b_{HOP}<B_{SRS}$.

SCPI command:
CONFigure[:LTE]:UL:SRS:BHOP on page 120

## 6.7.3 Defining the PUSCH Structure

The PUSCH structure settings contain settings that describe the physical attributes and structure of the PUSCH.

The PUSCH structure is part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.




Frequency Hopping Mode....64
PUSCH Hopping Offset....65
Number of Subbands....65
Info. in Hopping Bits....65

**Frequency Hopping Mode**
Frequency Hopping Mode specifies the hopping mode which is applied to the PUSCH. Available choices are NONE, Inter Subframe and Intra Subframe.

SCPI command:
CONFigure[:LTE]:UL:PUSCh:FHMode on page 123

**PUSCH Hopping Offset**
Sets the PUSCH Hopping Offset $N_{RB}^{HO}$.

The PUSCH Hopping Offset determines the first physical resource block and the maximum number of physical resource blocks available for PUSCH transmission if PUSCH frequency hopping is used.

SCPI command:
`CONFigure[:LTE]:UL:PUSCh:FHOFfset` on page 123

**Number of Subbands**
Number of Subbands specifies the number of subbands for PUSCH.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.5.3.2 Mapping to physical resources.

SCPI command:
`CONFigure[:LTE]:UL:PUSCh:NOSM` on page 123

**Info. in Hopping Bits**
Sets the information in hopping bits according to the PDCCH DCI format 0 hopping bit definition. This information determines whether type 1 or type 2 hopping is used in the subframe, and - in case of type 1 - additionally determines the exact hopping function to use.

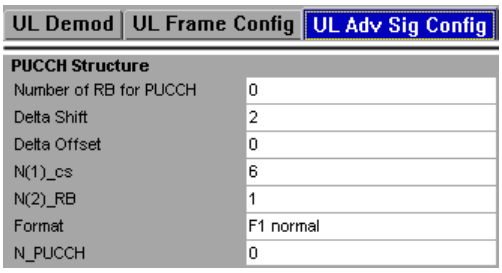
Frequency hopping is applied according to 3GPP TS36.213.

SCPI command:
`CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB` on page 123

## 6.7.4 Defining the PUCCH Structure

The PUCCH structure settings contain settings that describe the physical attributes and structure of the PUCCH.

The PUCCH structure is part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.




No. of RBs for PUCCH....66
Delta Shift....66
Delta Offset....66
N(1)_cs....66
N(2)_RB....66
Format....67
N_PUCCH....67

**No. of RBs for PUCCH**
Number of RBs for PUCCH configures the number of resource blocks for PUCCH.

The resource blocks for PUCCH are always allocated at the edges of the LTE spectrum. If an even number of PUCCH resource blocks is specified, half of the available number of PUCCH resource blocks are allocated on the lower and upper edge of the LTE spectrum (outermost resource blocks). In case an odd number of PUCCH resource blocks is specified, the number of resource blocks on the lower edge is one resource block larger than the number of resource blocks on the upper edge of the LTE spectrum.

SCPI command:
`CONFigure[:LTE]:UL:PUCCh:NORB` on page 125

**Delta Shift**
Sets the delta shift parameter, i.e. the cyclic shift difference between two adjacent PUCCH resource indices with the same orthogonal cover sequence (OC).

The delta shift determinates the number of available sequences in a resource block that can be used for PUCCH formats 1/1a/1b.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:
`CONFigure[:LTE]:UL:PUCCh:DESHift` on page 124

**Delta Offset**
Sets the PUCCH delta offset parameter, i.e. the cyclic shift offset. The value range depends on the selected Cyclic Prefix.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:
`CONFigure[:LTE]:UL:PUCCh:DEOFfset` on page 124

**N(1)_cs**
Sets the number of cyclic shifts used for PUCCH format 1/1a/1b in a resource block used for a combination of the formats 1/1a/1b and 2/2a/2b.

Only one resource block per slot can support a combination of the PUCCH formats 1/1a/1b and 2/2a/2b.

The number of cyclic shifts available for PUCCH format 2/2a/2b N(2)_cs in a block with combination of PUCCH formats is calculated as follow:

N(2)_cs = 12 - N(1)_cs -2

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:
`CONFigure[:LTE]:UL:PUCCh:N1CS` on page 125

**N(2)_RB**
Sets bandwidth in terms of resource blocks that are reserved for PUCCH formats 2/2a/2b transmission in each subframe.

Since there can be only one resource block per slot that supports a combination of the PUCCH formats 1/1a/1b and 2/2a/2b, the number of resource block(s) per slot available for PUCCH format 1/1a/1b is determined by N(2)_RB.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:
`CONFigure[:LTE]:UL:PUCCh:N2RB` on page 125

**Format**
Configures the physical uplink control channel format. Formats 2a and 2b are only supported for normal cyclic prefix length.

This parameter can be found in 3GPP TS36.211 V8.5.0, Table 5.4-1 Supported PUCCH formats.

SCPI command:
`CONFigure[:LTE]:UL:PUCCh:FORMat` on page 124

**N_PUCCH**
Sets the resource index for PUCCH format 1/1a/1b respectively 2/2a/2b.

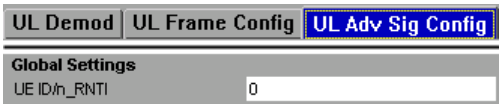
You can also select "Per Subframe" to set the N_PUCCH on a subframe level. For more information see chapter 6.6.3, "Configuring Subframes", on page 58.

SCPI command:
`CONFigure[:LTE]:UL:PUCCh:NPAR` on page 126

### 6.7.5 Defining Global Signal Characteristics

The global settings contain settings that apply to the complete signal.

The global settings are part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.




UE ID/n_RNTI.....67

**UE ID/n_RNTI**
Sets the radio network temporary identifier (RNTI) of the UE.

SCPI command:
`CONFigure[:LTE]:UL:UEID` on page 126

# 7 Analyzing Measurement Results

The "Measurement Settings" contain settings that configure various result displays. These settings are independent of the signal, they adjust the display of the results. You can open the dialog box with the "Meas Settings" softkey. The corresponding dialog box is made up of three tabs. By default, the "Selection" tab is the active one.


- Selecting a Particular Signal Aspect.....68
- Defining Measurement Units.....69
- Defining Various Measurement Parameters.....69
- Selecting the Contents of a Constellation Diagram.....70
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## 7.1 Selecting a Particular Signal Aspect

In the "Selection" tab of the "Measurement Settings" dialog box you can select specific parts of the signal you want to analyze.

**Subframe Selection**
Selects a particular subframe whose results the software displays.

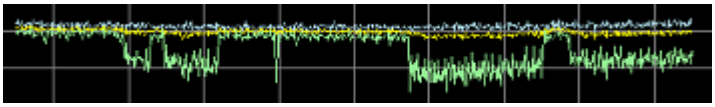
You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Inband Emission, Channel Flatness, Channel Flatness SRS, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, DFT Precoded Constellation, Allocation Summary and Bit Stream. If --- All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

**Example: Subframe selection**

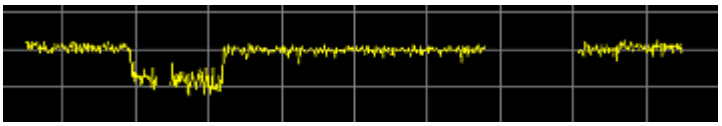
If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



with AV MI PK

- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



SCPI command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 126

## 7.2 Defining Measurement Units

In the "Units" tab of the "Measurement Settings" dialog box you can select the unit for various measurement results.

**EVM Unit**
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

SCPI command:
`UNIT:EVM` on page 127

## 7.3 Defining Various Measurement Parameters

In the "Misc" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.

**Bit Stream Format**
Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

**Examples:**

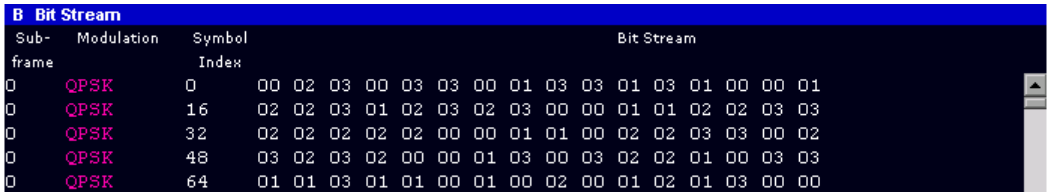



*Fig. 7-1: Bit stream display in uplink application if the bit stream format is set to "symbols"*

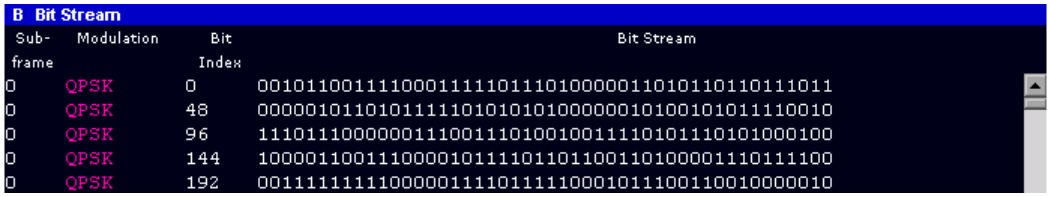



*Fig. 7-2: Bit stream display in uplink application if the bit stream format is set to "bits"*

SCPI command:
UNIT:BSTR on page 127

## 7.4 Selecting the Contents of a Constellation Diagram

The "Evaluation Filter" dialog box contains settings to configure the contents of a constellation diagram.

You can access the dialog box with the "Constellation Selection" softkey in the "Measurement" menu.

**Constellation Selection**
Filters the displayed results. You can filter the results by any combination of modulation, allocation ID, symbol, carrier or location. The results are updated as soon as any change to the constellation selection parameters is made.

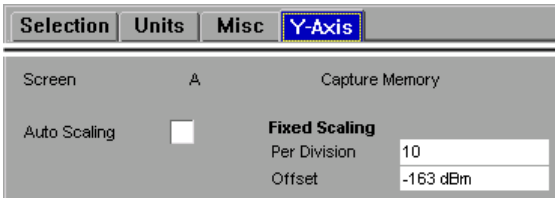
Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

You can filter the results by the following parameters:

- **Modulation**
  Filter by modulation scheme.
- **Symbol**
  Filter by OFDM symbol.
- **Carrier**
  Filter by subcarrier.

## 7.5 Scaling the Y-Axis

In the "Y-Axis" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.




**Y-Axis Scale**

The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you have turned on **automatic scaling**.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis. **Fixed scaling** becomes available when you turn off automatic scaling. For a fixed scaling, define the distance between two grid lines (scaling **per division**) and the point of origin of the y-axis (the **offset**).

SCPI command:
Automatic scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO` on page 130
Manual scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet` on page 130
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv` on page 130

## 7.6 Using the Marker

The firmware application provides a marker to work with. You can use a marker to mark specific points on traces or to read out measurement results.

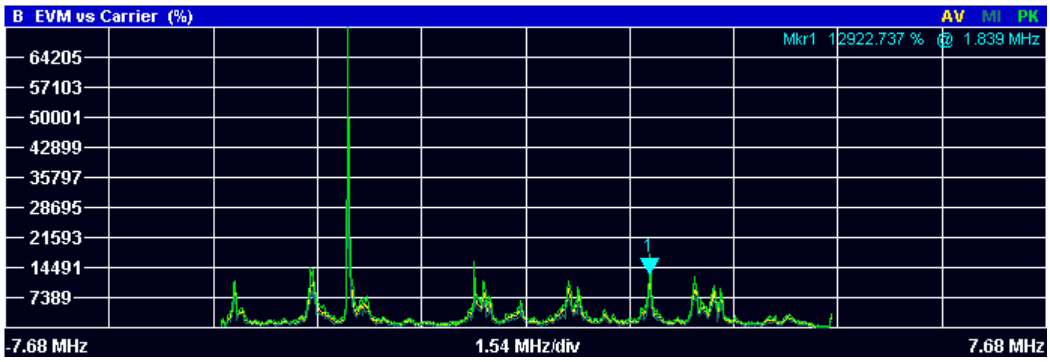



*Fig. 7-3: Example: Marker*

The MKR key opens the corresponding submenu. You can activate the marker with the "Marker 1" softkey. After pressing the "Marker 1" softkey, you can set the position of the marker in the marker dialog box by entering a frequency value. You can also shift the

marker position by turning the rotary knob. The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

The "Marker 1" softkey has three possible states:

If the "Marker 1" softkey is grey, the marker is off.

After pressing the "Marker 1" softkey it turns red to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.

After closing the dialog box, the "Marker 1" softkey turns green. The marker stays active.

Pressing the "Marker 1" softkey again deactivates the marker. You can also turn off the marker by pressing the "Marker Off" softkey.

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.

Note that the zoom function is not available for all result displays.

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker -> Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

`CALCulate<n>:MARKer<m>[:STATe]` on page 128

`CALCulate<n>:MARKer<m>:AOFF` on page 128

`CALCulate<n>:MARKer<m>:TRACe` on page 128

`CALCulate<n>:MARKer<m>:X` on page 128

`CALCulate<n>:MARKer<m>:Y?` on page 129

# 8 File Management

## 8.1 File Manager

The root menu of the application includes a File Manager with limited functions for quick access to file management functionality.

### Loading a Frame Setup

The frame setup or frame description describes the complete modulation structure of the signal, such as bandwidth, modulation, etc.

The frame setup is stored as an XML file. XML files are very commonly used to describe hierarchical structures in an easy-to-read format for both humans and PC.

A typical frame setup file would look like this:

```
<FrameDefinition LinkDirection="uplink" TDDULDLAllocationConfiguration="0"
RessourceBlocks="50" CP="auto" PhysLayCellIDGrp="Group 0" PhysLayID="ID 0"
N_RNTI="0" N_f="0" NOfSubbands="4" N_RB_HO="4" NOfRB_PUCCH="4"
DeltaShift="2" N1_cs="6" N2_RB="1" NPUCCH="0" DeltaOffset="0"
PUCCHStructureFormat="F1 normal" N_c_fastforward="1600"
HoppingBitInformation="0" FrequencyHopping="None" DemRefSeq="3GPP"
DemPilBoostdBPUSCH="0" DemPilBoostdBPUCCH="0" GroupHop="0" SequenceHop="0"
EnableN_PRS="1" Delta_ss="0" N_DMRS1="0" N_DMRS2="0" SoundRefSeq="3GPP"
SoundRefBoostdB="0" SoundRefPresent="0" SoundRefSymOffs="13" SoundRefCAZAC_u="2"
SoundRefCAZAC_q="0" SoundRefCAZAC_alpha="0" SoundRefCAZAC_mode="2" SoundRefB="0"
SoundRefC="0" SRSSubframeConfiguration="0" SoundRefN_CS="0" SoundRefK_TC="0"
SoundRefN_RRC="0" SoundRefb_hop="0" SoundRefI_SRS="0" SoundRefk0="24"
SoundRefNumSubcarrier="132">
  <Frame>
    <Subframe>
      <PRBs>
        <PRB Start="2" Length="10" Modulation="QPSK" PUCCHOn="0" BoostingdB="0"></PRB>
      </PRBs>
    </Subframe>
  </Frame>
  <stControl PhaseTracking="1" TimingTracking="0" CompensateDCOffset="1"
    UseBitStreamScrambling="1" ChannelEstimationRange="2" AutoDemodulation="1">
  </stControl>
</FrameDefinition>
```

All settings that are available in the "Demod Settings" dialog box are also in the frame setup file. You can enter additional allocations by adding additional PRB entries in the PRBs list.

To load a frame setup, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load Demod Setup" button.

**Loading an I/Q File**

The R&S FSQ is able to process I/Q data that has been captured with a R&S FSQ directly as well as data stored in a file. You can store I/Q data in various file formats in order to be able to process it with other external tools or for support purposes.

I/Q data can be formatted either in binary form or as ASCII files. The data is linearly scaled using the unit Volt (e.g. if a correct display of Capture Buffer power is required). For **binary** format, data is expected as 32-bit floating point data, Little Endian format (also known as LSB Order or Intel format). An example for binary data would be: 0x1D86E7BB in hexadecimal notation is decoded to -7.0655481E-3. The order of the data is either IQIQIQ or II...IQQ...Q.

For ASCII format, data is expected as I and Q values in alternating rows, separated by new lines: <I value 1>, <Q value 1>, <I value 2>, <Q value 2>, ...

To use data that has been stored externally, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load IQ Data" button.

## 8.2 SAVE/RECALL Key

Besides the file manager in the root menu, you can also manage the data via the SAVE/RECALL key.

The corresponding menu offers full functionality for saving, restoring and managing the files on the R&S FSQ. The save/recall menu is the same as that of the spectrum mode. For details on the softkeys and handling of this file manager, refer to the operating manual of the R&S FSQ.

# 9 Remote Commands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## 9.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

| Suffix | Description |
|---|---|
| <allocation> | Selects an allocation. |
| <analyzer> | No effect. |
| <antenna> | Selects an antenna for MIMO measurements. |
| <cluster> | Selects a cluster (uplink only). |
| <cwnum> | Selects a codeword. |
| <k> | Selects a limit line.<br>Irrelevant for the LTE application. |
| <m> | Selects a marker.<br>Irrelevant for the LTE application. |
| <n> | Selects a measurement window. |
| <subframe> | Selects a subframe. |
| <t> | Selects a trace.<br>Irrelevant for the LTE application. |

## 9.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSQ.

**Remote command examples**

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

### 9.2.1 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

**Example:**

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

### 9.2.2 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

**Example:**

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

### 9.2.3 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

**Example:**

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

### 9.2.4 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

**Example:**

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

### 9.2.5 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

**Example:**

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

- Numeric Values....78
- Boolean....78
- Character Data....79
- Character Strings....79
- Block Data....79

#### 9.2.5.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

**Example:**

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

**Querying numeric values**

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

**Example:**

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

#### 9.2.5.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

**Querying boolean parameters**

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

**Example:**

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

#### 9.2.5.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 9.2.1, "Long and Short Form", on page 76.

**Querying text parameters**

When you query text parameters, the system returns its short form.

**Example:**

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

#### 9.2.5.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark ( ' ) or a double quotation mark ( " ).

**Example:**

```
INSTRument:DELete 'Spectrum'
```

#### 9.2.5.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

# 9.3 Selecting and Configuring Measurements

## 9.3.1 Selecting Measurements

CALCulate<n>:FEED....80
DISPlay[:WINDow<n>]:TABLe....80

**CALCulate<n>:FEED** <DispType>

This command selects the measurement and result display.

**Parameters:**

<DispType> String containing the short form of the result display.

**'EVM:EVCA' (EVM vs carrier result display)**
**'EVM:EVSY' (EVM vs symbol result display)**
**'EVM:FEVS' (frequency error vs symbol result display)**
**'EVM:EVSU' (EVM vs subframe result display)**
**'PVT:CBUF' (capture buffer result display)**
**'SPEC:SEM' (spectrum emission mask)**
**'SPEC:ACP' (ACLR)**
**'SPEC:PSPE' (power spectrum result display)**
**'SPEC:FLAT' (spectrum flatness result display)**
**'SPEC:GDEL' (group delay result display)**
**'SPEC:FDIF' (flatness difference result display)**
**'SPEC:IE' (inband emission result display)**
**'CONS:CONS' (constellation diagram)**
**'CONS:DFTC' (DFT precoded constellation diagram)**
**'STAT:BSTR' (bitstream)**
**'STAT:ASUM' (allocation summary)**
**'STAT:CCDF' (CCDF)**

**Example:** `CALC2:FEED 'PVT:CBUF'`
Select Capture Buffer to be displayed on screen B.

**DISPlay[:WINDow<n>]:TABLe** <State>

This command turns the result summary on and off.

**Parameters:**

<State>

**ON**
Turns the result summary on and removes all graphical results from the screen.

**OFF**
Turns the result summary off and restores the graphical results that were previously set.

**Example:** `DISP:TABL OFF`
Turns the result summary off.

### 9.3.2 Configuring Frequency Sweep Measurements

ACLR and SEM measurements feature some settings particular to those measurements.

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[SENSe]:POWer:NCORrection....81
[SENSe]:POWer:SEM:CATegory....82
[SENSe]:SWEep:EGATe:AUTO....82

**[SENSe]:POWer:ACHannel:AACHannel** <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

**Parameters:**

<Channel>

**EUTRA**
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

**UTRA128**
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

**UTRA384**
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

**UTRA768**
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

**Example:** `POW:ACH:AACH UTRA384`
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

**[SENSe]:POWer:NCORrection** <State>

This command turns noise correction for ACLR measurements on and off.

**Parameters:**

<State> ON | OFF

*RST: OFF

**Example:** `POW:NCOR ON`

Activates noise correction.

---

**[SENSe]:POWer:SEM:CATegory** <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.101.

**Parameters:**

<Category> **A**

Category A

**B**

Category B

*RST: A

**Example:** `POW:SEM:CAT B`

Selects SEM category B.

---

**[SENSe]:SWEep:EGATe:AUTO** <State>

This command turns auto gating for SEM and ACLR measurements on and off.

This command is available for TDD measurements in combination with an external or IF power trigger.

**Parameters:**

<State> **ON**

Evaluates the on-period of the LTE signal only.

**OFF**

Evaluates the complete signal.

**Example:** `SWE:EGAT:AUTO ON`

Turns auto gating on.

## 9.4 Remote Commands to Perform Measurements

INITiate:CONTinuous....82
INITiate[:IMMediate]....83
INITiate:REFResh....83
[SENSe]:SYNC[:STATe]?....83

---

**INITiate:CONTinuous** <State>

This command controls the sweep mode.

**Parameters:**

<State> ON | OFF

**ON**
Continuous sweep

**OFF**
Single sweep

*RST: OFF

**Example:** `INIT:CONT OFF`
Switches the sequence to single sweep.
`INIT:CONT ON`
Switches the sequence to continuous sweep.

---

**INITiate[:IMMediate]**

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

In single sweep mode, you can synchronize to the end of the measurement with `*OPC`. In continuous sweep mode, synchronization to the end of the sweep is not possible.

**Example:** `INIT`
Initiates a new measurement.

**Usage:** Event

---

**INITiate:REFResh**

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

**Example:** `INIT:REFR`
The application updates the IQ results

**Usage:** Event

---

**[SENSe]:SYNC[:STATe]?**

This command queries the current synchronization state.

**Return values:**

<State> The string contains the following information.
A zero represents a failure and a one represents a successful synchronization.

**Example:** `SYNC:STAT?`
Would return, e.g. '1' for successful synchronization.

**Usage:** Query only

## 9.5 Remote Commands to Read Numeric Results

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FETCh:PLC:CIDGroup?....85
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FETCh:SUMMary:CRESt[:AVERage]?....85
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FETCh:SUMMary:POWer:MAXimum?....89
FETCh:SUMMary:POWer:MINimum?....89
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**FETCh:CYCPrefix?**

This command queries the cyclic prefix type that has been detected.

**Return values:**

<PrefixType> The command returns -1 if no valid result has been detected yet.

**NORM**
Normal cyclic prefix length detected

**EXT**
Extended cyclic prefix length detected

**Example:** `FETC:CYCP?`
Returns the current cyclic prefix length type.

**Usage:** Query only

**FETCh:PLC:CIDGroup?**

This command queries the cell identity group that has been detected.

**Return values:**

<CidGroup> The command returns -1 if no valid result has been detected yet.

Range: 0 to 167

**Example:** `FETC:PLC:CIDG?`
Returns the current cell identity group.

**Usage:** Query only

**FETCh:PLC:PLID?**

This command queries the cell identity that has been detected.

**Return values:**

<Identity> The command returns -1 if no valid result has been detected yet.

Range: 0 to 2

**Example:** `FETC:PLC:PLID?`
Returns the current cell identity.

**Usage:** Query only

**FETCh:SUMMary:CRESt[:AVERage]?**

This command queries the average crest factor as shown in the result summary.

**Return values:**

<CrestFactor> <numeric value>

Crest Factor in dB.

**Example:** `FETC:SUMM:CRES?`

Returns the current crest factor in dB.

**Usage:** Query only

---

**FETCh:SUMMary:EVM[:ALL]:MAXimum?**
**FETCh:SUMMary:EVM[:ALL]:MINimum?**
**FETCh:SUMMary:EVM[:ALL][:AVERage]?**

This command queries the EVM of all resource elements.

**Return values:**

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

**Example:** `FETC:SUMM:EVM?`

Returns the mean value.

**Usage:** Query only

---

**FETCh:SUMMary:EVM:PCHannel:MAXimum?**
**FETCh:SUMMary:EVM:PCHannel:MINimum?**
**FETCh:SUMMary:EVM:PCHannel[:AVERage]?**

This command queries the EVM of all physical channel resource elements.

**Return values:**

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

**Example:** `FETC:SUMM:EVM:PCH?`

Returns the mean value.

**Usage:** Query only

---

**FETCh:SUMMary:EVM:PSIGnal:MAXimum?**
**FETCh:SUMMary:EVM:PSIGnal:MINimum?**
**FETCh:SUMMary:EVM:PSIGnal[:AVERage]?**

This command queries the EVM of all physical signal resource elements.

**Return values:**

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

**Example:** `FETC:SUMM:EVM:PSIG?`
Returns the mean value.

**Usage:** Query only

---

**FETCh:SUMMary:EVM:SDQP[:AVERage]?**

This command queries the EVM of all DMRS resource elements with QPSK modulation of the PUSCH.

**Return values:**

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

**Example:** `FETC:SUMM:EVM:SDQP?`
Returns the EVM of all DMRS resource elements with QPSK modulation.

**Usage:** Query only

---

**FETCh:SUMMary:EVM:SDST[:AVERage]?**

This command queries the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH.

**Return values:**

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

**Example:** `FETC:SUMM:EVM:SDST?`
Returns the EVM of all DMRS resource elements with 16QAM modulation.

**Usage:** Query only

---

**FETCh:SUMMary:EVM:UCCD[:AVERage]?**

This command queries the EVM of all DMRS resource elements of the PUCCH as shown in the result summary.

**Return values:**

<EVM> EVM in % or dB, depending on the unit you have set.

**Example:** `FETC:SUMM:EVM:UCCD?`
Returns the average EVM of all DMRS resource elements.

**Usage:** Query only

**FETCh:SUMMary:EVM:UCCH[:AVERage]?**

This command queries the EVM of all resource elements of the PUCCH as shown in the result summary.

**Return values:**

<EVM> EVM in % or dB, depending on the unit you have set.

**Example:** `FETC:SUMM:EVM:UCCH?`
Returns the average EVM of all resource elements.

**Usage:** Query only

**FETCh:SUMMary:EVM:USQP[:AVERage]?**

This query returns the EVM for all QPSK-modulated resource elements of the PUSCH.

**Return values:**

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

**Example:** `FETC:SUMM:EVM:USQP?`
Queries the PUSCH QPSK EVM.

**Usage:** Query only

**FETCh:SUMMary:EVM:USST[:AVERage]?**

This query returns the the EVM for all 16QAM-modulated resource elements of the PUSCH.

**Return values:**

<EVM> EVM in % or dB, depending on the unit you have set.

**Example:** `FETC:SUMM:EVM:USST?`
Queries the PUSCH 16QAM EVM.

**Usage:** Query only

**FETCh:SUMMary:FERRor:MAXimum?**
**FETCh:SUMMary:FERRor:MINimum?**
**FETCh:SUMMary:FERRor[:AVERage]?**

This command queries the frequency error.

**Return values:**

<FreqError> <numeric value>
Minimum, maximum or average frequency error, depending on the last command syntax element.
Default unit: Hz

**Example:** `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

**Usage:** Query only

---

**FETCh:SUMMary:GIMBalance:MAXimum?**
**FETCh:SUMMary:GIMBalance:MINimum?**
**FETCh:SUMMary:GIMBalance[:AVERage]?**

This command queries the I/Q gain imbalance.

**Return values:**

<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

**Example:** `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

**Usage:** Query only

---

**FETCh:SUMMary:IQOFfset:MAXimum?**
**FETCh:SUMMary:IQOFfset:MINimum?**
**FETCh:SUMMary:IQOFfset[:AVERage]?**

This command queries the I/Q offset.

**Return values:**

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

**Example:** `FETC:SUMM:IQOF?`
Returns the current IQ-offset in dB

**Usage:** Query only

---

**FETCh:SUMMary:OSTP:MAXimum?**
**FETCh:SUMMary:OSTP:MINimum?**
**Usage:** Query only

---

**FETCh:SUMMary:POWer:MAXimum?**
**FETCh:SUMMary:POWer:MINimum?**
**FETCh:SUMMary:POWer[:AVERage]?**

This command queries the total power.

**Return values:**

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

**Example:** `FETC:SUMM:POW?`

Returns the total power in dBm

**Usage:** Query only

---

**FETCh:SUMMary:QUADerror:MAXimum?**
**FETCh:SUMMary:QUADerror:MINimum?**
**FETCh:SUMMary:QUADerror[:AVERage]?**

This command queries the quadrature error.

**Return values:**

<QuadError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

**Example:** `FETC:SUMM:QUAD?`

Returns the current mean quadrature error in degrees.

**Usage:** Query only

---

**FETCh:SUMMary:RSTP:MAXimum?**
**FETCh:SUMMary:RSTP:MINimum?**
**Usage:** Query only

---

**FETCh:SUMMary:SERRor:MAXimum?**
**FETCh:SUMMary:SERRor:MINimum?**
**FETCh:SUMMary:SERRor[:AVERage]?**

This command queries the sampling error.

**Return values:**

<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

**Example:** `FETC:SUMM:SERR?`

Returns the current mean sampling error in ppm.

**Usage:** Query only

**FETCh:SUMMary:TFRame?**

This command queries the trigger to frame result for downlink signals and the trigger to subframe result for uplink signals.

**Return values:**

<TrigToFrame> <numeric value>
Default unit: s

**Example:** `FETC:SUMM:TFR?`
Returns the trigger to frame value.

**Usage:** Query only

## 9.6 Remote Commands to Read Trace Data


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### 9.6.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

**Example:**

```
TRAC:DATA? TRACE1
```

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe[:DATA]?`).


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#### 9.6.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
- LIST
  Returns the contents of the ACLR table.

#### 9.6.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

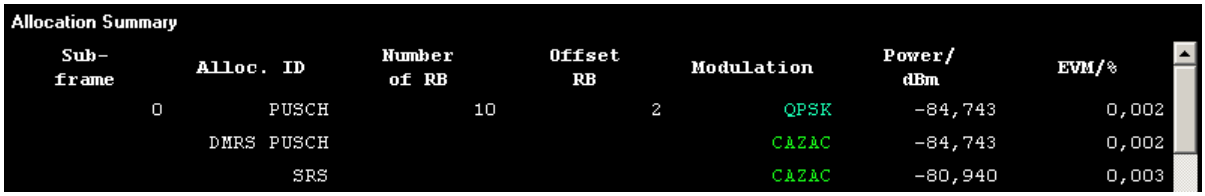
```
<subframe>, <allocation ID>, <number of RB>, <offset RB>,
<modulation>, <absolute power>, <EVM>, ...
```

The unit for `<absolute power>` is always dBm. The unit for `<EVM>` depends on `UNIT:EVM`. All other values have no unit.

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see chapter 9.6.1.17, "Return Value Codes", on page 98.

Note that the data format of the return values is always ASCII.

**Example:**



Allocation Summary

| Sub-frame | Alloc. ID | Number of RB | Offset RB | Modulation | Power/ dBm | EVM/% |
|---|---|---|---|---|---|---|
| 0 | PUSCH | 10 | 2 | QPSK | -84,743 | 0,002 |
| | DMRS PUSCH | | | CAZAC | -84,743 | 0,002 |
| | SRS | | | CAZAC | -80,940 | 0,003 |

`TRAC:DATA? TRACE1` would return:

```
0, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
0, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
0, -42, 0, 0, 6, -80.9404231343884, 3.97834623871343E-06,
...
```

### 9.6.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

`<subframe>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...`

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The `<modulation>` is encoded. For the code assignment see chapter 9.6.1.17, "Return Value Codes", on page 98.

For symbols or bits that are not transmitted, the command returns

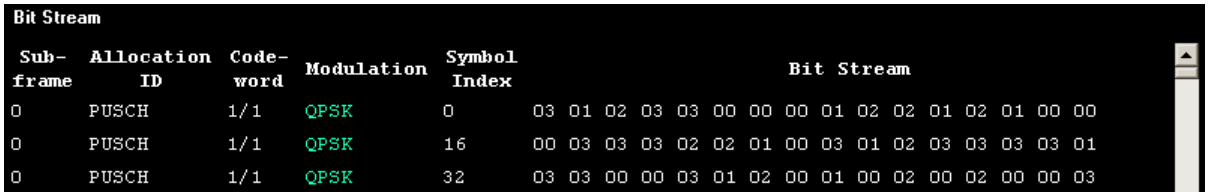
- "FF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

**Example:**



Bit Stream

| Sub-frame | Allocation ID | Code-word | Modulation | Symbol Index | Bit Stream |
|---|---|---|---|---|---|
| 0 | PUSCH | 1/1 | QPSK | 0 | 03 01 02 03 03 00 00 00 01 02 02 01 02 01 00 00 |
| 0 | PUSCH | 1/1 | QPSK | 16 | 00 03 03 03 02 02 01 00 03 01 02 03 03 03 03 01 |
| 0 | PUSCH | 1/1 | QPSK | 32 | 03 03 00 00 03 01 02 00 01 00 02 00 02 00 00 03 |

`TRAC:DATA? TRACE1` would return:

```
0, -40, 0, 2, 0, 03, 01, 02, 03, 03, 00, 00, 00, 01, 02, 02, ...
<continues like this until the next data block starts or the end of data is reached>
0, -40, 0, 2, 32, 03, 03, 00, 00, 03, 01, 02, 00, 01, 00, ...
```

#### 9.6.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

```
<absolute power>, ...
```

The unit is always dBm.

The following parameters are supported.

- TRACE1

#### 9.6.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  `<# of values>, <probability>, ...`
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2
  Returns the corresponding power levels (x-axis).
  `<# of values>, <relative power>, ...`
  The unit is always dB.
  The first value that is returned is the number of the following values.

#### 9.6.1.6 Channel Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

#### 9.6.1.7 Channel Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

#### 9.6.1.8 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

```
<group delay>, ...
```

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average group delay over all subframes.
- TRACE2
  Returns the minimum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.

#### 9.6.1.9 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Symb0][Carrier1]>, <Q[SF0][Symb0][Carrier1]>, ..., <I[SF0][Symb0][Carrier(n)]>, <Q[SF0][Symb0][Carrier(n)]>,

<I[SF0][Symb1][Carrier1]>, <Q[SF0][Symb1][Carrier1]>, ..., <I[SF0][Symb1][Carrier(n)]>, <Q[SF0][Symb1][Carrier(n)]>,

<I[SF0][Symb(n)][Carrier1]>, <Q[SF0][Symb(n)][Carrier1]>, ..., <I[SF0][Symb(n)][Carrier(n)]>, <Q[SF0][Symb(n)][Carrier(n)]>,

<I[SF1][Symb0][Carrier1]>, <Q[SF1][Symb0][Carrier1]>, ..., <I[SF1][Symb0][Carrier(n)]>, <Q[SF1][Symb0][Carrier(n)]>,

<I[SF1][Symb1][Carrier1]>, <Q[SF1][Symb1][Carrier1]>, ..., <I[SF1][Symb1][Carrier(n)]>, <Q[SF1][Symb1][Carrier(n)]>,

<I[SF(n)][Symb(n)][Carrier1]>, <Q[SF(n)][Symb(n)][Carrier1]>, ..., <I[SF(n)][Symb(n)][Carrier(n)]>, <Q[SF(n)][Symb(n)][Carrier(n)]>

With SF = subframe and Symb = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.
- TRACE2
  Returns the constellation points of the reference symbols included in the selection.
- TRACE3
  Returns the constellation points of the SRS included in the selection.

#### 9.6.1.10 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3

Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

#### 9.6.1.11 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<EVM>, ...
```

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

#### 9.6.1.12 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

#### 9.6.1.13 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<frequency error>,...
```

The unit is always Hz.

The following parameters are supported.

- TRACE1

#### 9.6.1.14 Inband Emission

For the Inband Emission result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns the relative resource block indices (x-axis values).
  `<RB index>, ...`
  The resource block index has no unit.

- TRACE2
  Returns one value for each resource block index.
  `<relative power>, ...`
  The unit of the relative inband emission is dB.
- TRACE3
  Returns the data points of the upper limit line.
  `<limit>, ...`
  The unit is always dB.

Note that you have to select a particular subframe to get results.

#### 9.6.1.15 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

`<power>,...`

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

#### 9.6.1.16 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns nine values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, ...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

#### 9.6.1.17 Return Value Codes

This chapter contains a list for encoded return values.

**<allocation ID>**

Represents the allocation ID. The value is a number in the range {1...-70}.

- **1** = Reference symbol
- **0** = Data symbol

- **-1** = Invalid
- **-40** = PUSCH
- **-41** = DMRS PUSCH
- **-42** = SRS PUSCH
- **-50** = PUCCH
- **-51** = DMRS PUCCH
- **-70** = PRACH

**<codeword>**

Represents the codeword of an allocation. The range is {0...2}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2

**<modulation>**

Represents the modulation scheme. The range is {0...8}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

**<number of symbols or bits>**

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

---

**TRACe[:DATA]?** <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 9.6.1, "Using the TRACe[:DATA] Command", on page 91.

**Query parameters:**

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

**Usage:** Query only

## 9.6.2 Remote Commands to Read Measurement Results

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?.....100
CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?.....100
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?.....101

**CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?** <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

**Query parameters:**

<Result>

**ALL**
Queries the overall limit check results.

**REL**
Queries the channel power limit check results.

**ABS**
Queries the distance to the limit line.

**Return values:**

<LimitCheck>

Returns two values, one for the upper and one for the lower adjacent channel.

**1**
Limit check has passed.

**0**
Limit check has failed.

**Example:**

```
CALC:LIM:ACP:ACH:RES? ALL
```

Queries the results of the adjacent channel limit check.

**Usage:** Query only

**CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?** <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

**Query parameters:**

<Result>

**ALL**
Queries the overall limit check results.

**REL**
Queries the channel power limit check results.

**ABS**
Queries the distance to the limit line.

**Return values:**

<LimitCheck> Returns two values, one for the upper and one for the lower alternate channel.

**1**
Limit check has passed.

**0**
Limit check has failed.

**Example:** `CALC:LIM:ACP:ALT:RES? ALL`
Queries the results of the alternate channel limit check.

**Usage:** Query only

---

**CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?**

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

**Suffix:**

<m> 1

**Query parameters:**

CPOW This parameter queries the signal power of the SEM measurement.

**Return values:**

<Result> **SEMResults**
Power level in dBm.

**ACLRResults**
Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

**Example:** `CALC1:MARK:FUNC:POW:RES?`
Returns the current ACLR measurement results.

**Usage:** Query only

## 9.7 Remote Commands to Configure the Application


- Remote Commands for General Settings....102
- Advanced General Settings....109
- Configuring Uplink Signal Demodulation....113
- Configuring Uplink Frames....115
- Defining Advanced Signal Characteristics....119


### 9.7.1 Remote Commands for General Settings

This chapter contains remote control commands necessary to control the general measurement settings.

For more information see chapter 6.2, "General Settings", on page 41.

#### 9.7.1.1 Defining Signal Characteristics


CONFigure[:LTE]:DUPLexing....102
CONFigure[:LTE]:LDIRection....102
CONFigure[:LTE]:UL:BW....103
CONFigure[:LTE]:UL:CYCPrefix....103
CONFigure[:LTE]:UL:NORB....103
[SENSe]:FREQuency:CENTer....103


**CONFigure[:LTE]:DUPLexing** <Duplexing>

This command selects the duplexing mode.

**Parameters:**

<Duplexing>
**TDD**
Time division duplex
**FDD**
Frequency division duplex
*RST: FDD

**Example:** `CONF:DUPL TDD`
Activates time division duplex.

**CONFigure[:LTE]:LDIRection** <Direction>

This command selects the link direction

**Parameters:**

<Direction>

**DL**
Downlink

**UL**
Uplink

**Example:** `CONF:LDIR DL`
EUTRA/LTE option is configured to analyze downlink signals.

---

**CONFigure[:LTE]:UL:BW** <Bandwidth>

This command selects the uplink bandwidth.

**Parameters:**

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

**Example:** `CONF:UL:BW BW1_40`
Sets a signal bandwidth of 1.4 MHz in uplink.

---

**CONFigure[:LTE]:UL:CYCPrefix** <PrefixLength>

This command selects the cyclic prefix for uplink signals.

**Parameters:**

<PrefixLength>

**NORM**
Normal cyclic prefix length

**EXT**
Extended cyclic prefix length

**AUTO**
Automatic cyclic prefix length detection

*RST: AUTO

**Example:** `CONF:UL:CYCP EXT`
Sets cyclic prefix type to extended.

---

**CONFigure[:LTE]:UL:NORB** <ResourceBlocks>

This command selects the number of resource blocks for uplink signals.

**Parameters:**

<ResourceBlocks> <numeric value>

*RST: 50

**Example:** `CONF:UL:NORB 25`
Sets the number of resource blocks to 25.

---

**[SENSe]:FREQuency:CENTer** <Frequency>

This command sets the center frequency for RF measurements.

**Parameters:**

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

**Example:** `FREQ:CENT 2GHZ`
Set the center frequency to 2 GHz.

### 9.7.1.2 Configuring the Input Level

CONFigure:POWer:EXPected:IQ<analyzer>....104
CONFigure:POWer:EXPected:RF<analyzer>....104
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet....104
INPut<n>:ATTenuation<analyzer>....105
INPut<n>:EATT....105
INPut<n>:EATT:STATe....105
INPut<n>:EATT:AUTO....105
[SENSe]:POWer:AUTO<analyzer>[:STATe]....106
[SENSe]:POWer:AUTO<analyzer>:TIME....106

**CONFigure:POWer:EXPected:IQ<analyzer>** <RefLevel>

This command defines the reference level when the input source is baseband.

**Parameters:**

<RefLevel> <numeric value>

Range: 31.6 mV to 5.62 V
*RST: 1 V
Default unit: V

**Example:** `CONF:POW:EXP:IQ2 3.61`
Sets the baseband-reference level used by analyzer 2 to 3.61 V.

**CONFigure:POWer:EXPected:RF<analyzer>** <RefLevel>

This command defines the reference level when the input source is RF.

**Parameters:**

<RefLevel> *RST: -30 dBm
Default unit: DBM

**Example:** `CONF:POW:EXP:RF3 -20`
Sets the radio frequency reference level used by analyzer 3 to -20 dBm.

**DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet** <Attenuation>

This command selects the external attenuation or gain applied to the RF signal.

**Parameters:**

<Attenuation> <numeric value>

*RST: 0
Default unit: dB

**Example:** `DISP:TRAC:Y:RLEV:OFFS 10`
Sets an external attenuation of 10 dB.

---

**INPut<n>:ATTenuation<analyzer>** <Attenuation>

This command sets the RF attenuation level.

**Parameters:**

<Attenuation> <numeric value>

*RST: 5 dB
Default unit: dB

**Example:** `INP:ATT 10`
Defines an RF attenuation of 10 dB.

---

**INPut<n>:EATT** <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with option R&S FSQ-B25, but not if R&S FSQ-B17 is active.

**Parameters:**

<Attenuation> Attenuation level in dB.

Default unit: dB

**Example:** `INP:EATT 10`
Defines an attenuation level of 10 dB.

---

**INPut<n>:EATT:STATe** <State>

This command turns the electronic attenuator on and off.

This command is available with option R&S FSQ-B25, but not if R&S FSQ-B17 is active.

**Parameters:**

<State> ON | OFF

*RST: OFF

**Example:** `INP:EATT:STAT ON`
Turns the electronic attenuator on.

---

**INPut<n>:EATT:AUTO** <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with option R&S FSQ-B25, but not if R&S FSQ-B17 is active.

**Parameters:**

<State> ON | OFF

*RST: OFF

**Example:** `INP:EATT:AUTO ON`

Turns automatic selection of electronic attenuation level on.

---

**[SENSe]:POWer:AUTO<analyzer>[:STATe]** <State>

This command initiates a measurement that determines the ideal reference level.

**Parameters:**

<State>

**OFF**

Performs no automatic reference level detection.

**ON**

Performs an automatic reference level detection before each measurement.

**ONCE**

Performs an automatic reference level once.

*RST: ON

**Example:** `POW:AUTO2 ON`

Activate auto level for analyzer number 2.

---

**[SENSe]:POWer:AUTO<analyzer>:TIME** <Time>

This command defines the track time for the auto level process.

**Parameters:**

<Time> <numeric value>

*RST: 100 ms

Default unit: s

**Example:** `POW:AUTO:TIME 200ms`

An auto level track time of 200 ms gets set.

### 9.7.1.3 Configuring the Data Capture

[SENSe][:LTE]:FRAMe:COUNt....106
[SENSe][:LTE]:FRAMe:COUNt:AUTO....107
[SENSe][:LTE]:FRAMe:COUNt:STATe....107
[SENSe]:SWEep:TIME....107

---

**[SENSe][:LTE]:FRAMe:COUNt** <Subframes>

This command sets the number of frames you want to analyze.

**Parameters:**

<Subframes> <numeric value>

*RST: 1

**Example:** `FRAM:COUN:STAT ON`

Activates manual input of frames to be analyzed.

`FRAM:COUN 20`

Analyzes 20 frames.

---

**[SENSe][:LTE]:FRAMe:COUNt:AUTO** <State>

This command turns automatic selection of the number of frames to analyze on and off.

**Parameters:**

<State> **ON**

Selects the number of frames to analyze according to the LTE standard.

**OFF**

Turns manual selection of the frame number on.

**Example:** `FRAM:COUN:AUTO ON`

Turns automatic selection of the analyzed frames on.

---

**[SENSe][:LTE]:FRAMe:COUNt:STATe** <State>

This command turns manual selection of the number of frames you want to analyze on and off.

**Parameters:**

<State> **ON**

You can set the number of frames to analyze.

**OFF**

The R&S FSQ analyzes a single sweep.

*RST: ON

**Example:** `FRAM:COUN:STAT ON`

Turns manual setting of number of frames to analyze on.

---

**[SENSe]:SWEep:TIME** <CaptLength>

This command sets the capture time.

**Parameters:**

<CaptLength> Numeric value in seconds.

Default unit: s

**Example:** `SWE:TIME 40`

Defines a capture time of 40 seconds.

### 9.7.1.4 Configuring On/Off Power Measurements

CONFigure[:LTE]:OOPower:NFRames....108

**CONFigure[:LTE]:OOPower:NFRames** <Frames>

This command defines the number of frames that are analyzed for On/Off Power measurements.

**Parameters:**

<Frames> <numeric value>

**Example:** `CONF:OOP:NFR 10`
Defines 10 frames to be analyzed.

### 9.7.1.5 Triggering Measurements

TRIGger[:SEQuence]:HOLDoff<analyzer>....108
TRIGger[:SEQuence]:IFPower:HOLDoff....108
TRIGger[:SEQuence]:IFPower:HYSTeresis....108
TRIGger[:SEQuence]:LEVel<analyzer>:POWer....109
TRIGger[:SEQuence]:MODE....109

**TRIGger[:SEQuence]:HOLDoff<analyzer>** <Offset>

This command defines the trigger offset.

**Parameters:**

<Offset> <numeric value>

*RST: 0 s
Default unit: s

**Example:** `TRIG:HOLD 5MS`
Sets the trigger offset to 5 ms.

**TRIGger[:SEQuence]:IFPower:HOLDoff** <Offset>

This command defines the holding time before the next trigger event.

Note that this command is available for **any trigger source**, not just IF Power.

**Parameters:**

<Offset> Range: 150 ns to 10 s
*RST: 150 ns
Default unit: s

**Example:** `TRIG:IFP:HOLD 1`
Defines a holdoff of 1 second.

**TRIGger[:SEQuence]:IFPower:HYSTeresis** <Hysteresis>

This command defines the trigger hysteresis.

**Parameters:**

<Hysteresis> Range: 3 to 50
*RST: 3
Default unit: dB

**Example:** `TRIG:IFP:HYST 10`
Defines a trigger hysteresis of 10 dB.

---

**TRIGger[:SEQuence]:LEVel<analyzer>:POWer** <Level>

This command defines the trigger level for an IF power trigger.

**Parameters:**

<Level> Default unit: DBM

**Example:** `TRIG:LEV:POW 10`
Defines a trigger level of 10 dBm.

---

**TRIGger[:SEQuence]:MODE** <Source>

This command selects the trigger source.

**Parameters:**

<Source> **EXTernal**
Selects external trigger source.

**IFPower**
Selects the IF power trigger source.

**IMMediate**
Selects free run trigger source.

*RST: IMMediate

**Example:** `TRIG:MODE EXT`
Selects an external trigger source.

## 9.7.2 Advanced General Settings

### 9.7.2.1 Controlling I/Q Data

[SENSe]:SWAPiq.....109

---

**[SENSe]:SWAPiq** <State>

This command turns a swap of the I and Q branches on and off.

**Parameters:**

<State> ON | OFF

*RST: OFF

**Example:** `SWAP ON`
Turns a swap of the I and Q branches on.

### 9.7.2.2 Controlling the Input

For information on the remote commands for reference level and attenuation settings see chapter 9.7.1.2, "Configuring the Input Level", on page 104.

INPut:SELect....110
INPut<n>:FILTer:YIG:AUTO....110
INPut<n>:FILTer:YIG[:STATe]....110
TRACe:IQ:FILTer:FLATness....111

**INPut:SELect** <Source>

This command selects the signal source.

**Parameters:**
<Source>
**RF**
Selects the RF input as the signal source.
**AIQ**
Selects the analog baseband input as the data source. This source is available only with option R&S FSQ-B71.
**DIQ**
Selects the digital baseband input as the data source. This source is available only with option R&S FSQ-B17.

**Example:** `INP DIQ`
Selects the digital baseband input.

**INPut<n>:FILTer:YIG:AUTO** <State>

This command turns automatic control of the YIG filter on and off.

**Parameters:**
<State>
ON | OFF
*RST: ON

**Example:** `INP:FILT:YIG:AUTO ON`
Activates automatic control of the YIG filter.

**INPut<n>:FILTer:YIG[:STATe]** <State>

This command removes or adds the YIG filter from the signal path.

If you remove the filter, you can use the maximum bandwidth, but image frequency rejection is no longer ensured.

**Parameters:**
<State>
ON | OFF
*RST: ON

**Example:** `INP:FILT:YIG OFF`
Removes the YIG filter from the signal path.

---

**TRACe:IQ:FILTer:FLATness** <FilterType>

This command turns the wideband filter on and off.

**Parameters:**
<FilterType> **NORMal**
Uses the normal filter.
**WIDE**
Turns the wideband filter on.
*RST: NORMal

**Example:** `TRAC:IQ:FILT:FLAT WIDE`
Turns the wideband filter on.

### 9.7.2.3 Configuring the Baseband Input

INPut:IQ:BALanced[:STATe] ..... 111
INPut:IQ:IMPedance ..... 111
INPut:IQ:TYPE ..... 112
[SENSe]:IQ:LPASs[:STATe] ..... 112
[SENSe]:IQ:DITHer[:STATe] ..... 112

---

**INPut:IQ:BALanced[:STATe]** <State>

This command selects if the I/Q inputs are symmetrical (balanced) or asymmetrical (unbalanced)

This command requires option R&S FSQ-B71.

**Parameters:**
<State> ON | OFF
*RST: ON

**Example:** `INP:IQ:BAL ON`
Specifies symmetrical (balanced) IQ inputs.

---

**INPut:IQ:IMPedance** <Impedance>

This command selects the input impedance for I/Q inputs.

This command requires option R&S FSQ-B71.

**Parameters:**
<Impedance> LOW | HIGH
*RST: LOW

**Example:** `INP:IQ:IMP LOW`
Selects low input impedance for I/Q input.

**INPut:IQ:TYPE** <Path>

This command selects the input path for baseband input.

**Parameters:**

<Path>
**IQ**
I+j*Q
**I**
I only
**Q**
Q only

**Example:** `INP:IQ:TYPE I`
Uses I input as the baseband path.

**[SENSe]:IQ:LPASs[:STATe]** <State>

This command turns a baseband input lowpass filter on and off.

**Parameters:**

<State>
ON | OFF
*RST: ON

**Example:** `IQ:LPAS ON`
Activate the input lowpass.

**[SENSe]:IQ:DITHer[:STATe]** <State>

This command adds or removes a noise signal into the signal path (dithering).

**Parameters:**

<State>
ON | OFF
*RST: OFF

**Example:** `IQ:DITH ON`
Activate input dithering.

### 9.7.2.4 Configuring the Digital I/Q Input

INPut<n>:DIQ:SRATe....112
INPut<n>:DIQ:RANGe[:UPPer]....113

**INPut<n>:DIQ:SRATe** <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

**Parameters:**

<SampleRate>
*RST: 10 MHz
Default unit: Hz

**Example:** `INP:DIQ:SRAT 10MHZ`
Defines a sampling rate of 10 MHz.

**INPut<n>:DIQ:RANGe[:UPPer]** <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

**Parameters:**
<ScaleLevel> *RST: 1 V
Default unit: V

**Example:** `INP:DIQ:RANG 0.7`
Sets the full scale level to 0.7 V.

## 9.7.3 Configuring Uplink Signal Demodulation

### 9.7.3.1 Configuring the Data Analysis

[SENSe][:LTE]:UL:DEMod:AUTO....113
[SENSe][:LTE]:UL:DEMod:CBSCrambling....113
[SENSe][:LTE]:UL:DEMod:CDCoffset....114
[SENSe][:LTE]:UL:DEMod:CESTimation....114
[SENSe][:LTE]:UL:DEMod:SISYnc....114

**[SENSe][:LTE]:UL:DEMod:AUTO** <State>

This command turns automatic demodulation for uplink signals on and off.

**Parameters:**
<State> ON | OFF
*RST: ON

**Example:** `UL:DEM:AUTO OFF`
Deactivates automatic demodulation.

**[SENSe][:LTE]:UL:DEMod:CBSCrambling** <State>

This command turns scrambling of coded bits for uplink signals on and off.

**Parameters:**
<State> ON | OFF
*RST: ON

**Example:** `UL:DEM:CBSC OFF`
Deactivates the scrambling.

**[SENSe][:LTE]:UL:DEMod:CDCoffset** <State>

This command turns DC offset compensation for uplink signals on and off.

**Parameters:**

<State> ON | OFF

*RST: ON

**Example:** `UL:DEM:CDC OFF`

Deactivates DC offset compensation.

**[SENSe][:LTE]:UL:DEMod:CESTimation** <Type>

This command selects the channel estimation type for uplink signals.

**Parameters:**

<Type> PIL | PILPAY

**PIL**

Pilot only

**PILP**

Pilot and payload

*RST: PILP

**Example:** `UL:DEM:CEST PIL`

Uses only the pilot signal for channel estimation.

**[SENSe][:LTE]:UL:DEMod:SISYnc** <State>

This command turns suppressed interference synchronization on and off.

**Parameters:**

<State> ON | OFF

*RST: OFF

**Example:** `UL:DEM:SISY ON`

Turns suppressed interference synchronization on.

### 9.7.3.2 Compensating Measurement Errors

[SENSe][:LTE]:UL:TRACking:PHASe....114
[SENSe][:LTE]:UL:TRACking:TIME....115

**[SENSe][:LTE]:UL:TRACking:PHASe** <Type>

This command selects the phase tracking type for uplink signals.

**Parameters:**

<Type>

**OFF**
Deactivate phase tracking

**PIL**
Pilot only

**PILP**
Pilot and payload

*RST: OFF

**Example:** `SENS:UL:TRAC:PHAS PILP`
Use pilots and payload for channel estimation.

---

**[SENSe][:LTE]:UL:TRACking:TIME** <State>

This command turns timing tracking for uplink signals on and off.

**Parameters:**

<State> ON | OFF

*RST: OFF

**Example:** `UL:TRAC:TIME ON`
Activates timing tracking.

## 9.7.4 Configuring Uplink Frames

### 9.7.4.1 Configuring TDD Signals

CONFigure[:LTE]:UL:TDD:SPSC....115
CONFigure[:LTE]:UL:TDD:UDConf....115

---

**CONFigure[:LTE]:UL:TDD:SPSC** <Configuration>

This command selects the special subframe configuration for LTE uplink signals.

**Parameters:**

<Configuration> <numeric value>

**Example:** `CONF:UL:TDD:SPSC 2`
Selects special subframe configuration 2.

---

**CONFigure[:LTE]:UL:TDD:UDConf** <Configuration>

This command selects the UL/DL TDD subframe configuration for uplink signals.

**Parameters:**

<Configuration> Range: 0 to 6
*RST: 0

**Example:** `CONF:UL:TDD:UDC 4`
Selects allocation configuration number 4.

### 9.7.4.2 Configuring the Physical Layer Cell Identity

CONFigure[:LTE]:UL:PLC:CID....116
CONFigure[:LTE]:UL:PLC:CIDGroup....116
CONFigure[:LTE]:UL:PLC:PLID....116

**CONFigure[:LTE]:UL:PLC:CID** <CellId>

This command defines the cell ID.

**Parameters:**
<CellId>
**AUTO**
Automatically defines the cell ID.
**<numeric value>**
Number of the cell ID.
Range: 0 to 503

**CONFigure[:LTE]:UL:PLC:CIDGroup** <GroupNumber>

This command selects the cell identity group for uplink signals.

**Parameters:**
<GroupNumber>
Range: 1 to 167
*RST: 0

**Example:** `CONF:UL:PLCI:CIDG 12`
Selects cell identity group 12.

**CONFigure[:LTE]:UL:PLC:PLID** <Identity>

This command selects the physical layer identity for uplink signals.

**Parameters:**
<Identity>
**AUTO**
Automatic selection
**0...2**
Manual selection
*RST: AUTO

**Example:** `CONF:DL:PLC:PLID 2`
Sets the physical layer identity to 2.
`CONF:DL:PLC:PLID AUTO`
Physical layer ID is selected automatically.

### 9.7.4.3 Configuring Subframes

CONFigure[:LTE]:UL:CSUBframes....117
CONFigure[:LTE]:UL:SFNO....117
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount....117
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset....117
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:POWer....118
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT....118
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation....118

**CONFigure[:LTE]:UL:CSUBframes** <NofSubframes>

This command selects the number of configurable subframes in the uplink signal.

**Parameters:**

<NofSubframes> Range: 0 to 9
*RST: 1

**Example:** `CONF:UL:CSUB 5`
Sets the number of configurable subframes to 5.

**CONFigure[:LTE]:UL:SFNO** <Offset>

This command defines the system frame number offset.

The application uses the offset to demodulate the frame.

**Parameters:**

<Offset> <numeric value>
*RST: 0

**Example:** `CONF:UL:SFNO 2`
Selects frame number offset 2.

**CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount** <NofRBs>

This command selects the number of resource blocks in an uplink subframe.

**Parameters:**

<NofRBs> <numeric value>
*RST: 11

**Example:** `CONF:UL:SUBF8:ALL:RBC 8`
Subframe 8 consists of 8 resource blocks.

**CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset** <RBOffset>

This command defines the resource block offset in an uplink subframe.

**Parameters:**

<RBOffset> <numeric value>
*RST: 2

**Example:** `CONF:UL:SUBF8:ALL:RBOF 5`
Subframe 8 has a resource block offset of 5.

---

**CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:POWer** <Power>

This command defines the (relative) power of an uplink allocation.

**Parameters:**
<Power> <numeric value>
*RST: 0
Default unit: DB

**Example:** `CONF:UL:SUBF8:ALL:POW -1.3`
Sets the power of the allocation in subframe 8 to -1.3 dB.

---

**CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT** <Content>

This command allocates a PUCCH or PUSCH to an uplink allocation.

**Parameters:**
<Content> **NONE**
Turns off the PUSCH and the PUCCH.
**PUCCh**
Turns on the PUCCH.
**PUSCh**
Turns on the PUSCH.
**PSCC**
Turns on the PUCCH as well as the PUSCH.
*RST: PUSC

**Example:** `CONF:UL:SUBF8:ALL:CONT PUCC`
Subframe 8 contains a PUCCH.

---

**CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation** <Modulation>

This command selects the modulation of an uplink allocation.

**Parameters:**
<Modulation> QPSK | QAM16 | QAM64
*RST: QPSK

**Example:** `CONF:UL:SUBF8:ALL:MOD QPSK`
The modulation of the allocation in subframe 8 is QPSK.

## 9.7.5 Defining Advanced Signal Characteristics

### 9.7.5.1 Configuring the Demodulation Reference Signal

CONFigure[:LTE]:UL:DRS:DSSHift....119
CONFigure[:LTE]:UL:DRS:GRPHopping....119
CONFigure[:LTE]:UL:DRS:NDMRs....119
CONFigure[:LTE]:UL:DRS:PUCCh:POWer....119
CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer....120
CONFigure[:LTE]:UL:DRS:SEQHopping....120

**CONFigure[:LTE]:UL:DRS:DSSHift** <Shift>

This command selects the delta sequence shift of the uplink signal.

**Parameters:**
<Shift> <numeric value>
*RST: 0

**Example:** `CONF:UL:DRS:DSSH 3`
Sets the delta sequence shift to 3.

**CONFigure[:LTE]:UL:DRS:GRPHopping** <State>

This command turns group hopping for uplink signals on and off.

**Parameters:**
<State> ON | OFF
*RST: OFF

**Example:** `CONF:UL:DRS:GRPHopping ON`
Activates group hopping.

**CONFigure[:LTE]:UL:DRS:NDMRs** <nDMRS>

This command defines the $n_{DMRS}$.

**Parameters:**
<nDMRS> <numeric value>

**Example:** `CONF:UL:DRS:NDMR 0`
Selects $n_{DMRS}$ 0.

**CONFigure[:LTE]:UL:DRS:PUCCh:POWer** <Power>

This command sets the relative power of the PUCCH.

**Parameters:**
<Power> *RST: 0
Default unit: DB

**Example:** `CONF:UL:DRS:PUCC:POW 2`
Sets the power of the PUCCH to 2 dB.

---

**CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer** <Power>

This command sets the relative power of the PUSCH.

**Parameters:**
<Power> *RST: 0
Default unit: DB

**Example:** `CONF:UL:DRS:POW 2`
Sets the relative power of the PUSCH to 2 dB.

---

**CONFigure[:LTE]:UL:DRS:SEQHopping** <State>

This command turns sequence hopping for uplink signals on and off.

**Parameters:**
<State> ON | OFF
*RST: OFF

**Example:** `CONF:UL:DRS:SEQH ON`
Activates sequence hopping.

### 9.7.5.2 Configuring the Sounding Reference Signal

CONFigure[:LTE]:UL:SRS:BHOP....120
CONFigure[:LTE]:UL:SRS:BSRS....121
CONFigure[:LTE]:UL:SRS:CSRS....121
CONFigure[:LTE]:UL:SRS:CYCS....121
CONFigure[:LTE]:UL:SRS:ISRS....121
CONFigure[:LTE]:UL:SRS:NRRC....121
CONFigure[:LTE]:UL:SRS:POWer....122
CONFigure[:LTE]:UL:SRS:STAT....122
CONFigure[:LTE]:UL:SRS:SUConfig....122
CONFigure[:LTE]:UL:SRS:TRComb....122

---

**CONFigure[:LTE]:UL:SRS:BHOP** <Bandwidth>

This command defines the frequency hopping bandwidth $b_{hop}$.

**Parameters:**
<Bandwidth> <numeric value>
*RST: 0

**Example:** `CONF:UL:SRS:BHOP 1`
Sets the frequency hopping bandwidth to 1.

**CONFigure[:LTE]:UL:SRS:BSRS** <Bandwidth>

This command defines the bandwidth of the SRS ($B_{SRS}$).

**Parameters:**

<Bandwidth> <numeric value>

*RST: 0

**Example:** `CONF:UL:SRS:BSRS 1`
Sets the SRS bandwidth to 1.

**CONFigure[:LTE]:UL:SRS:CSRS** <Configuration>

This command defines the SRS bandwidth configuration ($C_{SRS}$).

**Parameters:**

<Configuration> <numeric value>

*RST: 0

**Example:** `CONF:UL:SRS:CSRS 2`
Sets the SRS bandwidth configuration to 2.

**CONFigure[:LTE]:UL:SRS:CYCS** <CyclicShift>

Sets the cyclic shift n_CS used for the generation of the sounding reference signal CAZAC sequence.

**Parameters:**

<CyclicShift> <numeric value>

*RST: 0

**Example:** `CONF:UL:SRS:CYCS 2`
Sets the cyclic shift to 2.

**CONFigure[:LTE]:UL:SRS:ISRS** <ConfIndex>

This command defines the SRS configuration index ($I_{SRS}$).

**Parameters:**

<ConfIndex> <numeric value>

*RST: 0

**Example:** `CONF:UL:SRS:ISRS 1`
Sets the configuration index to 1.

**CONFigure[:LTE]:UL:SRS:NRRC** <FreqDomPos>

Sets the UE specific parameter Freq. Domain Position $n_{RRC}$.

**Parameters:**

<FreqDomPos> <numeric value>

*RST: 0

**Example:** `CONF:UL:SRS:NRRC 1`

Sets $n_{RRC}$ to 1.

---

**CONFigure[:LTE]:UL:SRS:POWer** <Power>

Defines the relative power of the sounding reference signal.

**Parameters:**

<Power> <numeric value>

*RST: 0

Default unit: DB

**Example:** `CONF:UL:SRS:POW -1.2`

Sets the power to -1.2 dB.

---

**CONFigure[:LTE]:UL:SRS:STAT** <State>

Activates or deactivates the sounding reference signal.

**Parameters:**

<State> ON | OFF

*RST: OFF

**Example:** `CONF:UL:SRS:STAT ON`

Activates the sounding reference signal.

---

**CONFigure[:LTE]:UL:SRS:SUConfig** <Configuration>

This command defines the SRS subframe configuration.

**Parameters:**

<Configuration> <numeric value>

*RST: 0

**Example:** `CONF:UL:SRS:SUC 4`

Sets SRS subframe configuration to 4.

---

**CONFigure[:LTE]:UL:SRS:TRComb** <TransComb>

This command defines the transmission comb ($k_{TC}$).

**Parameters:**

<TransComb> <numeric value>

*RST: 0

**Example:** `CONF:UL:SRS:TRC 1`

Sets transmission comb to 1.

### 9.7.5.3 Defining the PUSCH Structure

CONFigure[:LTE]:UL:PUSCh:FHMode....123
CONFigure[:LTE]:UL:PUSCh:FHOFfset....123
CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB....123
CONFigure[:LTE]:UL:PUSCh:NOSM....123

**CONFigure[:LTE]:UL:PUSCh:FHMode** <HoppingMode>

This command selects the frequency hopping mode in the PUSCH structure.

**Parameters:**

<HoppingMode>

**NONE**
No hopping

**INTer**
Inter subframe hopping

**INTRa**
Intra subframe hopping

*RST: NONE

**Example:**
```
CONF:UL:PUSC:FHM NONE
```
Deactivates frequency hopping for the PUSCH.

**CONFigure[:LTE]:UL:PUSCh:FHOFfset** <Offset>

This command defines the frequency hopping offset for the PUSCH.

**Parameters:**

<Offset>

<numeric value>

*RST: 4

**Example:**
```
CONF:UL:PUSC:FHOF 5
```
Sets the hopping offset to 5.

**CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB** <HBInfo>

This command defines the information in hopping bits of the PUSCH.

**Parameters:**

<HBInfo>

<numeric value>

Range: 0 to 3
*RST: 0

**Example:**
```
CONF:UL:PUSC:FHOP:IIHB 1
```
Defines type 1 as the information in hopping bits.

**CONFigure[:LTE]:UL:PUSCh:NOSM** <NofSubbands>

This command defines the number of subbands/M of the PUSCH.

**Parameters:**

<NofSubbands> <numeric value>

*RST: 4

**Example:** `CONF:UL:PUSC:NOSM 2`

Sets the number of subbands to 2.

### 9.7.5.4 Defining the PUCCH Structure

CONFigure[:LTE]:UL:PUCCh:DEOFfset....124
CONFigure[:LTE]:UL:PUCCh:DESHift....124
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CONFigure[:LTE]:UL:PUCCh:NORB....125
CONFigure[:LTE]:UL:PUCCh:NPAR....126

**CONFigure[:LTE]:UL:PUCCh:DEOFfset** <Offset>

This command defines the delta offset of the PUCCH.

**Parameters:**

<Offset> <numeric value>

Range: 0 to 2
*RST: 0

**Example:** `CONF:UL:PUCC:DEOF 2`

Sets the delta offset to 2.

**CONFigure[:LTE]:UL:PUCCh:DESHift** <Shift>

This command defines the delta shift of the PUCCH.

**Parameters:**

<Shift> <numeric value>

Range: 1 to 3
*RST: 2

**Example:** `CONF:UL:PUCC:DESH 3`

Sets the delta shift of the PUCCH to 3.

**CONFigure[:LTE]:UL:PUCCh:FORMat** <Format>

This command selects the PUCCH format.

Note that formats 2a and 2b are available for normal cyclic prefix length only.

**Parameters:**

<Format> **F1N (F1 normal)**
**F1S (F1 shortened)**
**F1AN (F1a normal)**
**F1AS (F1a shortened)**
**F1BN (F1b normal)**
**F1BS (F1b shortened)**
**F2 (F2)**
**F2A (F2a)**
**F2B (F2b)**
**F3 (F3)**
*RST: F1N

**Example:** `CONF:UL:PUCC:FORM F1N`
Sets the PUCCH format to F1 normal.

---

**CONFigure[:LTE]:UL:PUCCh:N1CS** <N1cs>

This command defines the N(1)_cs of the PUCCH.

**Parameters:**

<N1cs> <numeric value>
*RST: 6

**Example:** `CONF:UL:PUCC:N1CS 4`
Sets N(1)_cs to 4.

---

**CONFigure[:LTE]:UL:PUCCh:N2RB** <N2RB>

This command defines the N(2)_RB of the PUCCH.

**Parameters:**

<N2RB> <numeric value>
*RST: 1

**Example:** `CONF:UL:PUCC:N2RB 2`
Sets N2_RB to 2.

---

**CONFigure[:LTE]:UL:PUCCh:NORB** <ResourceBlocks>

This command selects the number of resource blocks for the PUCCH.

**Parameters:**

<ResourceBlocks> <numeric value>
*RST: 0

**Example:** `CONF:UL:PUCC:NORB 6`
Sets the number of resource blocks to 6.

**CONFigure[:LTE]:UL:PUCCh:NPAR** <NPUCCH>

This command defines the N_PUCCH parameter in the PUCCH structure settings.

**Parameters:**

<NPUCCH> <numeric value>

**<numeric value>**

**SUBF**

Selects the definition of N_PUCCH on subframe level.

*RST: 0

**Example:** `CONF:UL:PUCC:NPAR 2`

Sets N_PUCCH to 2.

#### 9.7.5.5 Defining Global Signal Characteristics

CONFigure[:LTE]:UL:UEID....126

**CONFigure[:LTE]:UL:UEID** <ID>

Sets the radio network temporary identifier (RNTI) of the UE.

**Parameters:**

<ID> <numeric value>

*RST: 0

**Example:** `CONF:UL:UEID 2`

Sets the UE ID to 2.

## 9.8 Analyzing Measurement Results

### 9.8.1 General Commands for Result Analysis

[SENSe][:LTE]:SUBFrame:SELect....126
UNIT:BSTR....127
UNIT:EVM....127

**[SENSe][:LTE]:SUBFrame:SELect** <Subframe>

This command selects the subframe to be analyzed.

**Parameters:**

<Subframe> ALL | <numeric value>

**ALL**
Select all subframes

**0...39**
Select a single subframe

*RST: ALL

**Example:** `SUBF:SEL ALL`
Select all subframes for analysis.

---

**UNIT:BSTR** <Unit>

This command selects the way the bit stream is displayed.

**Parameters:**

<Unit> **SYMbols**
Displays the bit stream using symbols

**BITs**
Displays the bit stream using bits

*RST: SYMbols

**Example:** `UNIT:BSTR BIT`
Bit stream gets displayed using Bits.

---

**UNIT:EVM** <Unit>

This command selects the EVM unit.

**Parameters:**

<Unit> **DB**
EVM results returned in dB

**PCT**
EVM results returned in %

*RST: PCT

**Example:** `UNIT:EVM PCT`
EVM results to be returned in %.

## 9.8.2 Using Markers

CALCulate<n>:MARKer<m>:AOFF....128
CALCulate<n>:MARKer<m>[:STATe]....128
CALCulate<n>:MARKer<m>:TRACe....128
CALCulate<n>:MARKer<m>:X....128
CALCulate<n>:MARKer<m>:Y?....129

**CALCulate<n>:MARKer<m>:AOFF**

This command turns all markers and delta markers off.

**Suffix:**
<m> 1

**Example:** `CALC:MARK:AOFF`
Switches off all markers.

**Usage:** Event

**CALCulate<n>:MARKer<m>[:STATe]** <State>

This command turns markers on and off.

**Suffix:**
<m> 1

**Parameters:**
<State> ON | OFF
*RST: OFF

**Example:** `CALC:MARK3 ON`
Switches on marker 3 or switches to marker mode.

**CALCulate<n>:MARKer<m>:TRACe** <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

**Suffix:**
<m> 1

**Parameters:**
<Trace> **1 to 6**
Trace number the marker is assigned to.

**CALCulate<n>:MARKer<m>:X** <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

**Suffix:**
<m> 1

**Parameters:**
<Position> Numeric value that defines the marker position on the x-axis.
Default unit: The unit depends on the result display.

**Example:** `CALC:MARK:X 1GHZ`
Moves the marker to the frequency of 1 GHz.

**CALCulate<n>:MARKer<m>:Y?**

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

**Suffix:**
<m> 1

**Example:** `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

**Usage:** Query only

## 9.8.3 Scaling the Vertical Diagram Axis

**Programming example to scale the y-axis**

```
//Start EVM vs Symbol result display in screen B.
CALC2:FEED 'EVM:EVSY'
//Refresh the measurement results based on the contents of the capture buffer
INIT:IMM
//Select screen B.
DISP:WIND2:SEL
//Select dB as the EVM unit.
UNIT:EVM DB
//Define the point of origin of 5 dB on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:OFFS 5
//Define the distance of 10 dB between two grid lines on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:PERD 10
```

DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO....130
DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet....130
DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv....130

**DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO**

This command automatically adjusts the scale of the y-axis to the current measurement results.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

**Example:** `DISP:TRAC:Y:SCAL:AUTO`
Scales the y-axis of the selected result display.

**Usage:** Event

**DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet** <Origin>

This command defines the point of origin of the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

**Parameters:**
<Origin> Point of origin of the y-axis.
The unit depends on the result display you want to scale.

**Example:** See chapter 9.8, "Analyzing Measurement Results", on page 126.

**DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv** <Distance>

This command defines the distance between two grid lines on the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

**Parameters:**
<Distance> The unit depends on the result display you want to scale.

**Example:** See chapter 9.8, "Analyzing Measurement Results", on page 126.

## 9.9 Configuring the Software

CONFigure:PRESet....131
DISPlay[:WINDow<n>]:SELect....131
FORMat[:DATA]....131
MMEMory:LOAD:DEModsetting....131

**CONFigure:PRESet**

Initiates a preset to the default state of the software, and, if connected to an analyzer, also presets the analyzer.

**Example:** `CONF:PRES`
Presets the software.

**Usage:** Event

**DISPlay[:WINDow<n>]:SELect**

This command selects the measurement window.

**Example:** `DISP:WIND2:SEL`
Selects screen B.

**Usage:** Event

**FORMat[:DATA]** [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

**Parameters:**
<Format> ASCii | REAL
*RST: ASCii

**Example:** `FORM REAL`
The software will send binary data in Real32 data format.

**MMEMory:LOAD:DEModsetting** <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

**Setting parameters:**
<Path> String containing the path and name of the file.

**Example:** `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

**Usage:** Setting only

# List of Commands

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